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# STUDY TO IMPROVE POST PRODUCTION PLANNING IN THE DEPARTMENT OF DEFENSE FOR THE DIRECTOR FOR MAINTENANCE POLICY



Office of the Deputy Assistant Secretary
for Logistics
Department of Defense
Washington, D.C. 20301



This report is of a confidential nature and is intended solely for the information of the client to whom it is addressed.

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# I. EXECUTIVE SUMMARY

# I. EXECUTIVE SUMMARY

This chapter presents a summary of the results of Booz, Allen, and Hamilton's study to improve Post Production Support (PPS) planning in the Department of Defense (DOD). This area is of key concern because it involves most of the inventory that would be deployed in case of emergency or conflict. The inventory value of major systems and equipments is estimated to range from 200 to 300 billion dollars.

Because funds available for post production support are constrained by other national priorities, the report discusses areas of potential economies to free funds for investment in readiness of systems in the PPS time frame.

The organization of this chapter is presented in the following four sections:

- Purpose and Methodology
- Study Scope
- Discussion
- Recommendations.

## 1. PURPOSE AND METHODOLOGY

This study was conducted for the Deputy Assistant Secretary of Defense for Logistics, Office of the Secretary of Defense (OSD) to develop recommendations to improve the management and readiness of major systems in the post production phase.

The major focus of the study was to aid the OSD staff in a review of current top-level policies and management practices impacting the PPS time frame to identify major issues and opportunities for improvement.

The methodology employed in this study consisted of: (1) a review of industry and DOD literature on this subject, (2) construction of an initial "model" of the problems, major issues, and potential actions for improvement based upon the literature review and Booz, Allen's knowledge of the DOD, (3) review of existing or proposed top level policy and guidance, (4) expansion and refinement of the model through visits to seven selected contractors and seven DOD installations, (5) division of the problem into manageable subproblems, and (6) derivation of recommendations for improvement based on the findings and conclusions. Actions 1, 3, 4, 5, and 6 match the contract statement of work.

## 2. STUDY SCOPE

The initial focus of the study was the improvement of weapon system PPS planning. It quickly became obvious, however, that real progress was also dependent on many other factors. The scope was therefore broadened to a general management perspective, with an overall objective to attain PPS weapon readiness levels through economical logistic support.

A second scoping issue involves the possible restriction to post production unique issues. Such a restriction could result in few, if any, issues because of wide variation in weapon system production time frames. Rather, an attempt was made to restrict the study from the "front end" by avoiding issues currently addressed under Acquisition Support Planning.

The last scoping issue involves the point at which post production planning should normally begin. This is still an open issue.

This study assumes that post production planning should begin no later than the POM year that cessation of production is first a POM issue. Cessation of production applies to the series, model, or modification, e.g., F-16A, rather than the end of all F-16 production. Several major sources of potential cost inefficiency that may lie outside this time frame were also included.

## 3. DISCUSSION

There is significant concern in Congress and in the DOD about the readiness and out-year support costs of weapon systems in the PPS time frame.

The extended service life of many major systems is creating new strains on the defense logistics system. The Minuteman missile, for example, with an original design life of 10 years, is now expected to be in the inventory for approximately 30 to 40 years. Approximately half of its original parts are no longer in production.

Industry observes many problems and inefficiencies in DOD PPS management. Industry believes improved DOD PPS planning is needed and that their capabilities to support DOD in the PPS time frame are presently underutilized.

DOD personnel generally agree that the problems observed by industry frequently exist and have their genesis in DOD top management practices. There is reluctance in the services to place too great a dependence upon industry for a variety of reasons discussed in the body of the report.

## 4. RECOMMENDATIONS

This section contains the major recommendations derived from the findings and conclusions developed within the sample size and time constraints of the study. The recommendations are presented in the following three sections:

- General Management
- Weapon System Management
- Functional Management.

### (1) General Management

- The completion of the DOD initiative to develop needed PPS policy to fill the current void should be expedited.

- The numerous PPS initiatives in OSD, the services, and industry should be integrated and cross-pollinized. OSD resources should be augmented to expedite this action. Symposia on PPS problems and solutions should be sponsored by the OSD.

- Technological and demographic trends that have a major inpact on PPS management should be quantified where possible to expedite needed management change. These trends and their impact could be included in the OSD (MRA&L) Long Range Plan.

- A study should be conducted to document the amount of top level programmatic and budget turblence and the extent of its adverse impact on service PPS planning. Options for turbulence reduction should be explored.

### (2) Weapon System Management

- System readiness measures should be made a major focus of PPS system management. Such measures should be specific rather than general, and PPS support resources should be related to such measures. OSD should undertake a review of system readiness measures used in PPS management of major systems.

- The completion of the OSD initiative to extend ILS acquisition planning to PPS management should be expedited. Formal PPS system plans should also be required in the new PPS policy. In addition, the elements to be covered in such PPS planning should be identified.

- A study should be conducted of the wide variance in service PPS system management practice to identify practices that warrent more extensive use. The study should include possible ways to improve the current imbalance between system and functional management in the PPS time frame.

- The growing need for engineering services and configuration management updating because of longer service lives should be considered for major points of focus in the PPS system management trials being sponsored by OSD.

- Funds dedicated to post production support system improvement should be reviewed for adequacy in terms of the product improvement potential for improved readiness or cost benefits.

- A study should be made to determine the need and desirability of selective use of the Minuteman approach (or other alternatives) to offset less accurate PPS budget estimates due to less accurate demand and pricing data in later portion of the PPS time frame.

(3) Functional Management - Procurement

- A study should be conducted to evaluate the feasibility and benefits of contract incentives to counter negative contractor motivational forces to accurately classify data restrictions and procurement codings.

- A study should be conducted of one or more DOD support organizations to evaluate the potential for savings of money and time through greater use of multiyear and requirement contracts and the prescreening provisions of the new draft breakout guidance.

- A study of PPS competitive procurement practices from a "systems" viewpoint, including all major costs and performance results, should be undertaken to determine what actions can diminish current field personnel reservations concerning the true benefits of competition.

(4) Functional Management-Maintenance

- OSD should continue its review of plans for transition from interim contractor to organic support to ensure a conservative pace unless circumstances warrant a faster, but more costly, transition.

- Cost visibility of organic versus industry major system overhaul decisions, and OSD review of such decisions, should be required to enable management to consider investment of the funds saved by choosing the most economic alternative in other priority needs.

- Alternate approaches to current organic overhaul policy, such as the current Air Force study, should be studied since long range technology and demographic trends may adversely affect the economics and feasibility of maintaining an organic capability based on mission essentialtiy.

(5) Functional Management - Supply

- The OSD initiatives to allow long lead time funding for spares and to allow contractor carrying charges under controllable government-industry contractor support planning agreements should be expedited because of the savings potential.

- Economic order quantity theory and economic production rate theory should be reviewed for merger possibilities and the results tested for savings in selective areas.

# II. STUDY SCOPE, METHODOLOGY, AND READINESS TERMINOLOGY

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In recent years, concern about defense capabilities and costs has risen substantially. A major portion of this general concern has been with the readiness of operational units and with the cost of the support associated with major weapons systems and equipment during the extended period after production. As part of the OSD management effort to address this concern, Booz, Allen & Hamilton undertook a three-month study to clarify the various issues involved and to propose possible courses of action to improve post production readiness as economically as possible.

This chapter discusses the following:

- Study Scope
- Methodology
- Readiness Terminology.

## 1. STUDY SCOPE

The initial focus of the study was the improvement of weapon support PPS planning. This focus was based on the industry literature portrayal of post production support problems observed by defense contractors in their role of performing various parts of the total actions involved in post production management by the services. Figure 1 lists the most common post production support problems found in the industry literature.

However, this focus raised several questions over the course of this study:

- Should the study be limited to PPS planning or should it include PPS management in general?
- Should the study concentrate only on issues totally unique to PPS or should it include issues with a major impact on PPS?
- Should the time frame of concern begin with post production or post fielding?

FIGURE 1
Problems Observed by Industry

Poor readiness and sustainability

Weak industrial base

Uneconomic spares order quantities

Diminishing sources - loss of skills

International logistics ramifications

Poor Feedback (product) and DOD planning to industry

System deterioration (age, use)

Decline in service skills

Poor configuration control

Factory test equipment disappearance

Lack of support for test equipment.

It quickly became apparent that many actions beyond improved planning would be necessary to achieve a major impact. The primary focus of the study was therefore oriented to attainment of PPS weapon system readiness through economical logistic support.

The second question has been the subject of considerable recent discussion. Restriction of the study to those issues or actions totally unique to PPS is conceptually attractive since it provides a simple boundary for action. However, such a boundary could seriously limit the study for several reasons.

The production time frames on some systems are so long that the system would experience, to some degree, all or most of the major problems of PPS. Thus no unique PPS issues would exist. Second, a number of key decisions in terms of major PPS economic impact, such as the timing of the transition from interim contractor to organic support, permanent organic vs. industry overhaul, and the quality of the data rights package procured, may well be made before PPS planning is initiated. Third, the problems observed by industry, which in a sense represent the genesis of this study, have the two problems cited above. Because of these considerations, the scope of the study was not restricted to issues totally unique to PPS.

However, the magnitude of some of the problem areas identified for improvement do vary significantly with the point in time in the PPS phase. For example, service system management practices, adequacy of configuration management and technical data, the need for PPS-oriented product improvement, and DMS and loss of skills are very sensitive to the point of time since the end of production. PPS procurement, maintenance, and supply decisions and practices are less PPS time-sensitive. Some decisions are made before production ends. Other practices are the same in both the production and PPS time frames.

Rejection of the unique restriction raises a still another question. A focus on factors that have major impact on PPS could theoretically extend the time frame involved back to very early acquisition activities. To do so would needlessly entail a review of most of the actions taken by MRA&L in the past several years to improve support planning in acquisition. The study was therefore bound from the front end by an attempt to avoid active initiatives in acquisition support management.

The third question, the appropriate time frame of concern, is still an open question. It needs early resolution because its answer impacts one of the major recommendations for improvement.

The actual scope employed in the study is as follows:

- Primary weapon system and depot level focus
- No "O" or "I" level
- Little FMS or industrial base
- Timeframe
  - PPS planning begins at least two POM years before the production cessation year of a series, model, or mod (e.g., F-16A, M60A, MK 86 Mod 8) becomes a POM issue
- Decisions with major PPS impact
  - Organic vs. industry
  - Transition pace to organic
  - Data rights and procurement coding.

The conduct of the study had several constraints worth mentioning. The literature review did not include many Rand and LMI reports of potential use because such access could not be arranged. Second, the "sample size," in terms of visits to industy and DOD organizations was

limited to seven each. Lastly, the study involved review of a "moving" target because many actions germane to this study are in various states of progress in the DOD and industry.

## 2. METHODOLOGY

The methodology employed in this study consisted of: (1) a review of industry and DOD literature on this subject, (2) construction of an initial "model" of the problems, major issues, and potential action for improvement based upon the literature and Booz, Allen knowledge of the DOD, (3) review of existing or proposed top level policy and guidance, (4) expansion and correction of the model through visits to seven selected contractor and seven DOD installations (see Appendix A), (5) division of the problem into manageable subproblems, and (6) preparation of recommendations for improvement. Actions 1, 3, 4, 5, and 6 match the contract statement of work.

## 3. READINESS TERMINOLOGY

The word readiness has many connotations in DOD and industry. One major usage generally assigns peacetime considerations as readiness and wartime considerations as sustainability.

Another DOD usage is contained in DODD 5000.39, "Acquisition and Management of Integrated Logistic Support for Systems and Equipment." Here system readiness is used to imply output measures that relate to peacetime readiness (to fight) and wartime usage (surge and sustained combat). Such parameters must now be used as a major management parameter during acquisition (the Carlucci initiatives). They vary with type of system and peacetime vs. wartime. Operational availability ($A_O$) is a widely used peacetime measure. $A_O$, sortie rates, and percent coverage are useful measures in combat. Because a major focus of this report is weapon systems and major equipment and their readiness, we will employ the term systems readiness or readiness in the 5000.39 connotation above.

# III. DISCUSSION

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This chapter examines the PPS problem from several different perspectives. The following subjects are discussed:

- The reality of readiness and cost concerns
- The industry perspective
- The service perspective
- A case history - Minuteman.

### 1. THE REALITY OF THE READINESS AND COST CONCERNS

There can be no doubt that the concern is real. There is widespread concern in Congress, industry, and the DOD about the readiness and outyear support costs of weapon systems in the PPS time frame. Congressional concern has increased to the point that DOD is now required to submit an annual report concerning material readiness of operational defense units. Because the report is classified, specific details of the degree of readiness are not repeated here. However, some judgments as to the magnitude of the DOD concern can be gleaned from Appendix B, an unclassified part of the latest DOD Material Readiness Report to Congress which discusses DOD initiatives to address the problem.

Readiness concerns are also widely documented in the industry literature and government reports, as illustrated by references 1 through 26 in the bibliography in Appendix C.

A growing percentage of the members of Congress is becoming concerned with the diversion of funds from social programs to defense under the present administration, and many senior DOD officials feel the current support for larger defense budgets is tenuous. This belief is frequently expressed in speeches by top level DOD managers who are concerned that if the present DOD budget increases are not managed efficiently this time there will be no future opportunity offered by the American taxpayer. There is widespread belief that post production support funds could be used more effectively. Consequently, improved post production management could provide a twofold benefit: immediate improvements to force readiness and sustainability and the generation of the popular opinion that DOD is not wasting funds garnished from other needed

government programs. Cost concerns are expressed in the literature and various studies in the public domain, as illustrated in references 27 through 41 in the bibliography in Appendix C.

## 2. A CASE HISTORY - MINUTEMAN

The current Air Force-Boeing post production support effort on Minuteman is an excellent example of the potential problems faced on weapon systems in the PPS time frame and a possible approach to improve post production management.

Minuteman had an original design life of 10 years. It is now estimated to be in the inventory for 30 to 40 years. Half of the original Minuteman parts are no longer procurable. Because of diminishing source problems, increasing spares costs (up to 1723 percent increases), and leadtime problems (as much as quadruple increases), increasing inability to predict funding requirements, and configuration control problems, the Air Logistics Center at Ogden contracted with Boeing to augment the ALC staff in addressing current Minuteman post production problems. The cost of this proposal contract is a small (less than 5 percent) part of annual Minuteman support costs.

The proposed Boeing effort consists of development and operation of a data base on several thousand logistically significant (possible loss of manufacturing sources) items. The data would be used to aid problem identification/prioritization and conduct of trade studies of alternatives. This information would then be used to develop integrated plans, schedules, and funding profiles. The system would provide Ogden ALC information on configuration, substitutions, spares availability, costs and lead times, and forecasts of parts unavailability. Terminals at Ogden, Boeing and other major Minuteman contractors would permit rapid data call-ups.

Contractor involvement should not reduce competition. Hardware responsibilities are unchanged. The improved predictive capability may provide more time for competitive procurement study. The contractor support capability is maintained by its continuing role. Areas in which the contractor believes he brings unique capabilities to this task are listed below:

- Data Base Development
  - Contractor drawings and kits not in government drawings
  - Short lead times to obtain computer resources

- Data Availability
  - Manufacturer only reliable source for cost, time, and predicted unavailability
  - Better major contractors leverage with vendors
- Trade Studies
  - Design familiarity to evaluate substitutes
  - Design capability to develop/evaluate alternative designs
  - Accurate cost and schedule data for alternatives
  - System engineering capability.

It should be noted that many Air Force personnel question aspects of this proposed trial. However, the case is an excellent example of PPS weapon system problems, and the approach proposed is worth examining in detail for possible use in other PPS system "trial" programs being sponsored by DOD.

## 3. INDUSTRY PERSPECTIVE

This section of the report summarizes the results of the industry literature review and the defense contractor visits. The industry literature reviewed is contained in references 42 through 54 in the bibliography in Appendix C.

A general summary of the industry literature is that: (1) DOD planning for post production support is poor, resulting in poor readiness and cost inefficiencies, (2) the DOD depot structure needlessly duplicates the industrial base, and (3) industry feels that it generally has little information on DOD post production support plans and is thus kept in a reactive and inefficient mode. The feelings expressed in the literature in regard to the depot structure caused difficulties with some DOD personnel in the conduct of this study. While organic vs. industry overhaul is addressed as one major facet of this study as part of the larger issue of improving readiness at least cost, immediate "wholesale" shifts of work load from the DOD depots to industry is not a viable consideration.

The visits to industry included two aircraft manufacturers, a "software" house, three electronic equipment

manufacturers, several missile manufacturers, and an automotive manufacturer. These are identified in Appendix A. To a considerable degree, the literature findings were confirmed.

The industry focus is based upon their observations of apparent inefficient practices (see Figure 1, page II-2) in their role of providing material and services to DOD in the post production support time frame. It is important to note that, in many cases, industry is only consulted or engaged when problems (and thus inefficiency) arise. Industry sees many potential benefits from improved post production support planning. Figure 2 summarizes those listed in the literature. Lastly, the literature emphasizes that industry dislikes its reactive role. It very much desires greater knowledge of DOD post production support planning to guide its own planning and to provide greater service for DOD during post production support in areas where use of its special expertise would be beneficial.

## 4. SERVICE PERSPECTIVE

The DOD literature and studies tend to focus on readiness rather than costs. References 8 through 16 and 18 through 26 illustrate this tendency. However, cost is the focus of several interesting papers, listed in References 27, 40, 41, and 42 in the bibliography in Appendix C.

FIGURE 2
Benefits of Improved PPS Planning
Envisioned by Industry

| DOD | INDUSTRY |
|---|---|
| Lower Spares Cost | Stable Employment |
| Better $A_o$ | Improved Loading |
| Shorter Lead Times | Broader Scope |
| Less O&S Cost through R&M Improvement | Better Insight for ECPs, MODs, $P^3I$, etc. |
| Better Design Feedback | |
| PIPs | |
| Future Design | |
| Better Mobilization Base | |

The visits to DOD installations gave a different perspective of the "problems" of post production support than that obtained from industry. Industry tends to focus on "inefficiency" observed at the contractual interface or in service use of their products. The DOD organizations

visited are aware of most of the problems observed by industry (in some cases, the source of the problem is industry). They have numerous initiatives underway that address these problems. Management at the Air Force Logistics Command, the Navy Aviation Supply Office, and the Ships Parts Control Center are particularly aggressive in attempts to improve the current situations. These are identified in the various areas involved later in this report. There is widespread feeling in such DOD organizations that improvements are possible. However, they feel that, in many instances, progress is inhibited by priorities, policy (or lack thereof), budget and program turbulence, or practices dictated from above. The services have fear of over dependence on industry. The reasons for this are discussed later in the report.

# IV. FINDINGS

## IV. FINDINGS

This chapter contains the findings of the study, which are organized into the following three general areas:

- General Management
- Weapon System Management
- Functional Management.

### 1. GENERAL MANAGEMENT

#### (1) Policy

No DOD Policy exists on post production system support management. Although functional policy abounds, at this time there is no policy for post production support from a weapon system or ILS viewpoint. Until recently, there was no focal point in OSD assigned responsibility for such a viewpoint.

Some may question the above because DOD guidance on acquisition management of major systems do in fact address major modifications and preplanned product improvement, both of which can occur in the PPS time frame. However, specific policy for PPS system management is not covered.

OSD is now addressing this problem. A draft Post Production Support Directive was prepared as part of this contract (Appendix D) to serve as a departure point for further development by OSD and the services. It should begin coordination later this year. The thrust of this draft directive is to require an "ILS" approach to post production support activity. It requires improved post production support planning, with appropriate linkage with acquisition support planning. It encourages a quantitative approach to post production support problems. In short, it requires adoption of some of the successful acquisition support practices appropriate to the post production time frame.

#### (2) Initiatives

Numerous initiatives in OSD, the services, and industry addressing various aspects of the PPS prob-

lems are underway. OSD initiatives are listed in Appendix A. Service initiatives were discussed briefly in Chapter III. Specific service initiatives are mentioned in this chapter and Chapter V (as appropriate) in the specific area of interest. The industry associations have also been active in various aspects of the PPS problem.

No focal point for PPS management existed until recently. One has now been established in OSD (MRA&L) and a project officer assigned part-time. The major requirement now is sufficient personnel resources and travel funds to help do the staff work and analysis necessary to develop and implement a continued management approach to PPS issues. A precedent for such a staff and the potential benefits it can provide is available in the management structure for acquisition logistics. It may be argued that such a focal point is unnecessary since Defense Research and Engineering personnel are "responsible" for their systems "womb-to-tomb." However, they do not in practice address the day-to-day needs from a PPS perspective.

While some may say that the services don't need more OSD guidance (and this can be true on occasion), in practice the services frequently are hindered by functional interests when they have no OSD advocate on their initiatives to improve weapon system readiness. The services are the real loser when there is no OSD focal point to "cross-pollinate" successful service initiatives which improve readiness.

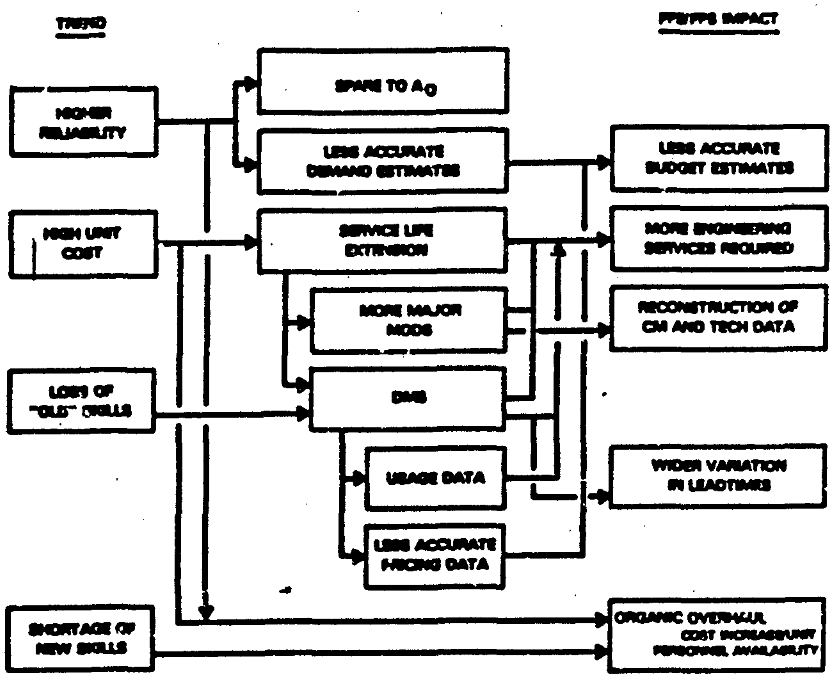
(3) Trend Impact

Technology and demographic trends impact PPS management. Figure 3 illustrates some of the more obvious relationships. The figure is illustrative, rather than definitive, since a definitive analysis was obviously beyond the scope and purpose of this study.

However, relationships shown are clearly impacting support management in the post production time frame. Some of the more obvious impacts follow:

- Higher Reliability means lower component and subassembly failure rates. A subsystem may now require 10 years before all major failures are experienced. This means that use of a 2-year base to estimate demand could grow increasingly inaccurate, thus impacting the accuracy of budget estimates. Higher reliability could also affect overhaul economics because the cost of facilitization may be spread over fewer units to be overhauled.

FIGURE 3
Impact of Technology and Demographic Trends on PPS




- Higher unit costs are causing service life extensions. This generates more modifications and more diminishing manufacturing source (DMS) problems. Both create greater demand for engineering services. Major modifications for service extension create new demands for updating configuration management and technical data. DMS and time diminish pricing history accuracy, again impacting budget estimates. Higher unit costs also impact the economics of overhaul location.

- Loss of "old" skills is one cause of the growing DMS problem.

- Shortage of new skills indicate DOD may ultimately need to change present practices which use large numbers of skilled personnel or partially duplicate other national capabilities. Boeing, for example, estimates it will ultimately have to perform the same workload with half its present professional work force. DOD and industry may need to take steps to avoid costly competition for scarce skills.

(4) Turbulence

Turbulence in top level programming and budgeting causes many inefficiencies in lower level management in the PPS time frame. This was reported by most DOD installations visited. The article "The Logistics Operators Meet the Challenge" (Reference 57 in the Bibliography, Appendix C), contains excellent examples of such turbulence.

(5) Information Exchange

Wide variation exists in communication between industry and DOD concerning PPS planning. As stated earlier, industry feels in a reactive mode, seldom privy to DOD plans. This attenuates industry ability to plan and frustrates their desire to be of greater assistance. Industry visits indicate extremely wide variation in the degree to which DOD provides and shares PPS planning information. DOD claims that they are seldom asked for information that they are quite willing to share. However, the DOD people who make this claim are not the same "people" industry indicates to be reluctant to share information.

## 2. WEAPON SYSTEM MANAGEMENT

(1) System Readiness

System Readiness is a useful measure for PPS as well as acquisition management; use of specific, rather than general, system readiness parameters can provide better readiness at lower costs; quantitative linkage of PPS support element resource and budget needs and readiness levels can improve the "marketability" of PPS support needs.

DOD has found use of such readiness measures as a major management point of focus to be very beneficial in improving the balance between performance and supportability. Because the most likely time of use of a system is its PPS time frame, use of such measures in PPS is even more important than in acquisition.

The DOD has launched a major effort to improve readiness measures and their use. The progress shown in the classified material readiness conference recently sponsored by OSD is impressive considering the short time frame when readiness has been a key initiative. However, much still remains to be done. Measurements and models useful to the PPS phase need continued attention. The measures selected for weapon system management and the degree of specificity are

keys to achievement of readiness with maximum economy. An example of this is contained in the paper by Berman and Bamforth presented at this year's Society of Logistics Engineering Symposium. The society has granted permission to include this paper, which is included as Appendix E.

(2) PPS Planning

Support planning deteriorates in the PPS time frame from a system viewpoint. There is currently no requirement for PPS planning in the ILS policy direction although this is now planned. There is also a need for formal PPS plans after cessation of production. There is no definition of the normal elements for inclusion in a PPS support plan and no Military Standard for PPS comparable to the acquisition military standards for ILS and Logistics Support Analysis.

(3) Practice Variance

System Management practice in the PPS time frame varies significantly. There appears to be a wide variation in service practice of weapon system management. For example, at one time the Air Force had fairly strong weapon system management in its Air Force Logistics Centers. This was deemphasized when attention was shifted to item management. AFLC is now in the process of reemphasizing and strengthening its systems management capability. Currently however, the AFLC System Manager may be the last to hear about a part or item problem on his system. The Navy has taken a systems approach in its supply management and has full life cycle system management in some cases. However, senior OSD officials question aspects of the Navy approach to system management, particularly in the PPS time frame.

Imbalance exists between service system program management and functional management interests during the PPS time frame. Several service system managers expressed significant frustration on their ability to influence functional practice impacting their programs.

As an example of this frustration consider the following situation at one DOD installation. Supply policy requires quarterly buys. Because of the high degree of competition achieved, procurement lead time is such that a new requirement is generated prior to the first buy. Procurement then logically wishes to combine the purchases, but this further delays the procurement. The system manager meanwhile is left without adequate stocks.

Figure 4 lists some of the major practices that introduce potential inefficiencies into system management in the time frame and scope used in this study. In most cases the service PPS manager has little or no input to decisions in the areas listed in this figure.

FIGURE 4
Sources of PPS Cost Inefficiencies

**Production of End Item**

1. Go organic before design is stable
2. Go organic even though far more costly than contractor support
3. Buy spares separate from production
4. Poor data rights and data package

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**Post Production**

5. Purchase of high cost spares in small quantities
6. Weak initial organic engineering capability
   - Loss of possible R&M and cost improvements through loss of contractor engineering continuity
7. Gradual deterioration of "procurement" CM and Tech Data
   - Impact on Manuals, Spares, TOs, etc.
8. Procurement methods
   - High administration costs
   - Loss of turnaround and lead time savings
9. Growing DMS cases-increased costs
10. Need for Mod or service life extension-"Fire Drill" to fix accumulated problems--higher costs--delays
11. Re-cycle

Figure 4 is a "worst case" scenario. The practices listed do not occur on all systems. But clearly they are of sufficient dollar magnitude that areas of potential savings to offset other increases necessary to improve readiness is a major PPS issue. Except for items 7, 9 and 10, the practices are not generally

time-sensitive to the PPS time frame. Some decisions are made long before the end of production. Others begin prior to end of production and carry on in post production.

(4) Extended Service Lives

Trends in extended service lives mean more modifications, more product improvements, and more DMS cases. Such trends are shown in Figure 3 on page 3 of this chapter. They were verified in discussions held in contractor and defense installations.

Extended services lives, DMS, and technology trends reduce the accuracy of demand and pricing data, and lead to less accurate PPS Budget estimates. This relationship was shown in Figure 3 of this chapter and occurs in the Minuteman case history in Chapter III.

## 3. FUNCTIONAL MANAGEMENT

(1) Procurement

Cost savings may be possible through improved procurement practices. There appears to be possible economies through greater use of existing procurement methods, such as competition, multiyear and supply and requirement contracts, and through greater procurement focus on saving time.

Savings from effective competition has long been a major focus of DOD procurement. However, there is evidence that DOD needs to do more to ensure that improper restrictions on technical data delivered to DOD do not restrict competition. Recent DOD Production Readiness Reviews indicate extensive problems in this regard. The DOD Product Engineering Services Office has other preliminary evidence that many MIL-STD parts are tied to restrictive prime contractor drawings. The GAO report, "DOD Loses Many Competition Procurement Opportunities" (Reference 59 in the bibliography in Appendix C), takes a similar view.

The problem is multifaceted. It involves the effectiveness of DOD review of contractor data classifications in acquisition as well as the procurement coding assigned by DOD logistic support centers or by contractors. Historically, DOD has tried several coding methods. The Air Force at one time paid contractors to do such coding; however, the Air Force Logistic Center visited reported the trend now is toward in-house Air Force coding. It would seem that neither method has been fully effective. OSD/DRE has initia-

tives addressing this problem. Regardless of the point of attack, review of contractor data rights classification or assignment of procurement codings, DOD manpower limitations could well limit the effectiveness of the corrective action.

We found some interest in multiyear procurement during our visits, but the possibilities for greater usage seem better than ever. Such usage is one of the Carlucci initiatives. Multiyear contracts can save lead time as well as money. The GAO has endorsed multiyear contract use in their report, "Federal Agencies should be Given General Multiyear Contractive Authority for Supplies and Services" (Reference 60 in the bibliography in Appendix C), although they now question the amount of savings due to "time value of money" considerations (many such contracts require higher front-end investment). There are other considerations and limitations, as discussed in the articles "Multiyear Procurement: A Current Perspective" (Reference 61 in the bibliography in Appendix C), and "Selecting Programs for Multiyear Procurement" (Reference 62 in the bibliography in Appendix C). It is interesting to note that some in the logistic community fear that use of multiyear in acquisition will "lock in" money for acquisitions thus forcing distribution of funding shortages toward post production support. Large-scale use of multiyear contracts in post production may be easier because the value of contracts are generally lower. Thus, the logistics community might counter the perceived threat and, in fact, perhaps reverse it.

Assuming that savings through competition are maximized, the other potential for savings is in time. There are several possibilities to do this. The first is greater use of requirement type contracts when a clear sole source condition exists. Again we encountered some such usage during our visits; however, the enthusiasm level varied considerably. We saw no signs of top management emphasis on requirement contracts. DOD top management has tended to focus on competition. Saving time has been largely a "local" issue in terms of reduction of administrative procurement lead-time. Anyone in the procurement system can remember letters (at least annually) from OSD discussing PPS competition. No one we talked to could recall a letter requesting attention to PPS procurement lead time. There may be possibilities of saving more time in the PPS procurement process. Conflicting stories were encountered in our visits. Some installations process competitive and sole source coded procurements differently (one place estimated a 90-day time difference). Others say a separate track (off-line) for some pro-

curements would make additional time savings possible. Some say the new draft DAR coverage on "break-out" will permit time savings because it has eliminated steps in the break-out process and specifically permits off-line (prior to generation of a purchase request) screening. Others say that it will make no difference because the steps deleted were not actually accomplished and the personnel are not available to make the investment in off-line screening.

A conceptual "best case" scenario can be constructed which achieves both competition and leadtime savings. This scenario competes spares and reparables in "life of item" support contracts, thus also saving 120 to 210 days pipeline time. In fact, this approach is planned for use on a major system developed commercially for FMS. The approach has been analyzed from a life cycle cost viewpoint and found viable. The DOD cannot generally use "life of item" contracts because there is currently a 5-year limit on multiyear contracts. But movement toward the "best case scenario" is possible.

Lastly, both contractors and service personnel privately noted problems with competition and set-asides. System manufacturers, for example, are routinely asked to bid on items that obviously have been broken out. Thus some time and effort is spent on "ritual" rather than the real objective. There is no doubt in the minds of most at the operating level that competition as practiced today ignores many widely known negative aspects. In fact, present competitive practice is a classic example of the bureaucracy silently accepting something in which they have less than total faith. In practice, this feeling undoubtedly results in considerable "lip service" to competition initiatives.

(2) <u>Maintenance</u>

Cost savings may be possible in overhaul. DOD spends approximately 11 billion dollars per year on equipment and system overhaul. This is an area where industry feels it can be of significant assistance to DOD. Contractors believe that organic vs. industry overhaul decisions should consider FMS and contractor impact. They feel depot overhaul data is a key for development of R&M improvements. They believe some organic overhaul decisions make little sense economically. Contractors also claim that greater participation would improve the industrial base and surge capability, although it is unclear whether they mean that such participation would improve the total organic-

industry base. DODD 4151.1 "Use of Contractor and DOD Resources for Maintenance of Materiel" has been recently revised to place greater emphasis on consideration of the contractor industrial base.

The first issue involves the time phasing of the transition from interim contractor support to an organic capability. Use of interim contractor support has been growing as systems have grown more complex. If this transition is done conservatively, i.e., not made until the design stabilizes, economies are possible because of less retrofit of spares, manuals, test equipment, etc. The 1965 LMI study, "Optimum Mix of Military/Defense Industry Capability" (Reference 63 in the bibliography in Appendix C), is an excellent discussion of this subject. OSD is evaluating this issue as part of DSARC reviews. However, paragraph F.2 of the new DODD 4151.1 could be interpreted to imply that mission essential items should be provided organic support as rapidly as possible. Because military systems and equipment mission essential are a large part of overhaul, the potential economies of a conservative transition could be lost.

The second finding involves the decision tree used in deciding organic vs. industry accomplishment of overhaul. Widespread industry feelings on this were expressed earlier. DOD has counterarguments. A 1977 study at the Naval Postgraduate School, "Total Contractor Logistic Support" (Reference 27 in the bibliography in Appendix C), summarizes one view of the pros and cons of this general issue, as shown in Figure 5.

FIGURE 5
Contractor Logistic Support

| Disadvantages | Advantages |
| --- | --- |
| Risk to Mission Accomplishment | Economy |
| Loss of Control | Flexibility |
| Loss of In-house Expertise | Reduction in Service Manpower |
| Loss of Sea-Shore Rotation Capability | |

Most of the above are obvious. A short explanation of others follows. Flexibility implies the abil-

ity to expand or contract more rapidly. Performance means that the cases examined had better NORS and OR rates than could have been achieved in-house. Risk to mission accomplishment considers strikes and other possible labor disputes. Loss of control means that a Commanding Officer's line of control would have to pass through his contracting officer. In their 1965 report, "The Optimum Mix of Military/Defense Industry Capability" (Reference 63 in the bibliography in Appendix C), LMI downgraded strike considerations as an issue. We agree with the Navy study, which says that most service objections to industry overhaul (strikes, certainty of dedicated capacity, etc.), have at least partial offsets and that the sea-shore rotation is the hardest disadvantage to overcome. However, the fears are not totally groundless. We encountered one case of bankruptcy in our visits. AFLC is currently reviewing new approaches to this decision in search of possible economies. From a purely economic viewpoint, industry is not always cheaper. In isolated cases, industry has actually been incapable.

The current decision tree allows a service to make organic decisions based on mission essential or depot capability essential, without cost visibility of economic implications and without OSD review. In some cases, industry can do the job much cheaper because of the high DOD facilitization costs. The difference may on occasion be several hundred millions of dollars. No corporation or no other DOD area, that we are cognizant of, makes decisions of such dollar magnitude without cost visibility. We fully support OSD plans to require cost visibility in the new decision tree now under preparation. In some cases, it may be desirable to go to industry and use the savings to reduce other shortfalls.

The last finding in the overhaul area involves the long range impact of technology and demographic trends on the organic vs. contractor issue. These trends, discussed in Chapter IV, may adversely affect the economics and feasibility of maintaining an organic overhaul capability, based on mission essentiality. The current approach is subject to wide variation in interpretation. It tends to exist as a system unto itself rather than an integrated part of a balanced depot, industrial base, and war reserve triad. There appear to be significant imbalances between these three "subsystems."

The literature in particular has addressed the industrial base issue. References 64 through 67 in the bibliography in Appendix C discuss various aspects

of the industrial base problem. DOD has a major initiative to improve the industrial base. However, the point here is balance. It is questionable logic to invest in a depot surge capability if war consumable stocks are insufficient to make depot repair a factor or if the industrial base is incapable of supplying parts needed to conduct organic repair. The depot structure is a political, as well as readiness and cost issue, and powerful conflicting interests are at work. Nevertheless, there is a need to examine other alternatives to the present overhaul decision policy and to examine the overhaul, industrial base, and war reserve issues as a "system" problem.

(3) DMS

DMS Initiatives appear generally adequate. The increasing diminishing manufacturing source problem has received greater attention in the past several years. It has been the subject of a number of reports in recent years, as illustrated in References 68 through 74 in the bibliography in Appendix C.

The Minuteman is an excellent example of the types of problems which can occur. Without greater management attention the problem is likely to grow since technology advancements generally are occurring more rapidly. Reference 75 in the bibliography in Appendix C is an excellent discussion of this in the electronic area. An OSD-Service-Industry group is revising policy on this subject. Drafts of this policy we have seen appear to contain most of the possible means to reduce this problem.

There are, however, some minor possibilities for further improvement. The first is based on the industry literature and involves "buying time" to solve DMS problems. The approach assumes that the probability of a no-source condition tends to increase nonlinearly with the increase in time since last buy. This appears intuitively logical. Thus, experience data, possibly by technology area, could be analyzed to locate the knee of the curve. Using this information, the computers could be programmed to kick out items not procured for "X" years some specified time period (the time normally required to "solve" an identified DMS problem) ahead of the normal practice. If a source exists, procurement could be returned to the normal time frame. Such an approach may be viable where DMS problems are heavy (e.g., DESI). It could also be combined with procedures for off-line screening in the breakout program.

The second potential method for improvement involves elimination or reduction of the DMS problem through focus on this problem in Post Production System Support Improvement efforts. This will be discussed in more detail in the next chapter.

A third possible improvement involves development and maintenance of a better management data base on the problem. This would include its magnitude, trends on frequency of occurrence, frequency of occurrence by technology area, etc. Such data could be useful in fostering a "rifle shot" vs. a "shotgun" approach to the DMS problem. While such data may be available, requests for such data to OSD were unsuccessful.

The last comment concerns the DAR case to offer contractors relief when a DMS case occurs. Current bid response time generally forces contractors to assume existence of a source for parts needed on PPS contracts. If this assumption is untrue, the contractor can be delinquent through no fault of his own. The case at hand would grant relief if this occurs. This seems equitable. Contractors report that without such relief, DOD tends to assume the contractor must take the burden of corrective actions. Using a more reasonable contract approach, such as the proposed clause, would foster a "team" approach to DMS situations.

(4) Supply

Economies may be possible in spares order quantities. DOD spares purchasing is "big business". A typical DOD supply center may make over 50,000 purchases valued at over one-half billion dollars per year. The industry literature and the industry visits repeatedly cited uneconomic production quantities in spares purchasing and repairable refurbishment as a source of potential savings.

OSD has initiatives to allow long lead time funding of spares, and to allow contractor carrying charges under controllable government/contract support planning agreements.

However, there is a possibility that a new EOQ approach could result in further savings. There is considerable service dissatisfaction with the amount of small quantity purchasing. EOQ theory tends to assume constant unit prices. Some question whether it considers set-up costs; others claim it does so implicitly. Others question whether it allows for learning curve considerations.

In practice, EOQ categorizes buys by dollar velocity (e.g., frequency of use times unit price). The higher the velocity, the more frequent the buy. In many cases, velocity is dominated by unit price. Therefore the higher priced items are bought most frequently and thus procured at uneconomic production rates. The Aviation Supply Office (ASO) has conducted studies which show savings of five percent by changing from quarterly to semi-annual purchase and ten percent from quarterly to annual (ASO Budget Execution Plan, Reference 58 in the bibliography in Appendix C). However, front end investment is required. Other DOD installations report savings through use of quantity price break information provided by contractors.

It is arguable that larger order quantities would improve readiness because there would be less chance of stock-out during part of the extended time frame which the larger order covers. The possibility of buying excess spares near the end of service life could be offset by reversion to more conservative policies at a designated point prior to the scheduled end of service life.

The present conservatism is understandable. Since provisioning by its nature can never be perfect, the area is made to order for "sensational" findings by "after-the-fact" review groups. Without an alternative focus, sparing policy makers had little choice not to be fiscally conservative. Given an alternative focus, the same policy makers have shown a willingness to subordinate fear of economic loss in favor of an output measure more related to the mission of the DOD. This is exemplified by the current shifting of initial spares purchasing from a fiscally constrained focus to a focus of meeting operational availability goals.

It is interesting to note that ASO estimates an 18-month break-even point. As an analogy, the Army approves capital investment projects (tools, etc.) if a three-year payback is possible. While procurement attempts to address this general issue by requesting "price breaks," DOD is frequently unable to take advantage of this because budgets are generally based on the original computed EOQ quantities.

# V. CONCLUSIONS AND RECOMMENDATIONS

# V. CONCLUSIONS AND RECOMMENDATIONS

This chapter contains conclusions and recommendations, which are organized into the following three major areas:

- General Management
- Weapon System Management
- Functional Management.

## 1. GENERAL MANAGEMENT

### (1) Policy

DOD policy for PPS Management of major systems is needed. Action initiated in this area should be expedited.

### (2) Initiatives

The numerous initiatives in OSD, the services, and industry would benefit from integration and cross-pollination. There is a need for stronger OSD leadership. This requires more resources for the OSD focal point. The resources assigned to the present OSD focal point for PPS are inadequate: they consist of one staff director and one part-time staff officer. Creation of a "satellite" support office, such as the one available to augment the Acquisition Support effort, should be considered. OSD should sponsor internal DOD and joint DOD-industy symposia.

### (3) Trend Impact

Analysis of the impact of technology and demographic trends or PPS management would foster more rapid adaption to change. PPS is included in the long-range plan under preparation by OSD (MRA&L). Extending or supplementing this beginning by the inclusion of quantitative trends of potential interest to PPS would help identify impacts earlier and help "market" necessary change. Consideration should also be given to the inclusion of a procurement section in the long range plan to serve as a forcing function for procurement focus on PPS problems.

(4) Turbulence

Reduction of PPS Programmatic and Budget Turbulence would improve PPS system planning and management. While this is widely recognized, it is difficult to address because part of the turbulence is beyond DOD control. Nevertheless, reduction of such turbulence could produce major benefits. It may therefore be useful to fully document the impact of such turbulence in case histories of some systems to quantify the problem and increase interest in turbulence reduction. OSD (MRA&L) should also follow the results of a current Defense System Management College (DSMC) contract to study acquisition budget turbulence for possible cross-pollination of results.

(5) Information Exchange

The variability in DOD-industry PPS information exchange adversely affects industry planning and needlessly creates "ill will". The apparent need here is for industry to specifically state what is needed and then determine if DOD has it and should share it. Refusal to share (when proper) is more serious and difficult to attack in the sense it is often rooted in emotion and past experience. Thus, some method is needed to encourage proper sharing and make it more uniform. A DOD Instruction on this subject is one possible solution.

2. WEAPON SYSTEM MANAGEMENT

(1) System Readiness

System readiness measures should be a major focus of PPS system management. New policy in development should specifically require such a focus. Since measures used have a significant impact on readiness and cost, OSD should undertake a review of system readiness measures in use by the services on all systems in the PPS time frame. Lastly the acquisition initiative to relate support resources and budgets to readiness should be followed for possible cross-pollination.

(2) PPS Planning

PPS planning for major systems needs to be improved. PPS planning from an "ILS systems" approach must begin prior to the end of production. A requirement for planning should be placed in the update of the ILS directive. A requirement for formal PPS

system plans should also be included in the new PPS directive. These actions are currently planned and should be expedited. Work should also begin on defining the appropriate elements or subjects to be covered in such planning.

Finally, there may be need for a MIL-STD on PPS, one of the proposals to support improved post production support management. This would be a MIL-STD similar to the latest versions of MIL-STD 785 and MIL-STD-470 for Reliability and Maintainability, respectively, as well as the draft replacement for MIL-STD-1388, Logistic Support Analysis, (e.g., task-oriented standard). The task orientation of these documents aids flexibility and tailoring. Figure 6, below, lists some possible tasks which might be cited in such a standard.

The argument for such a standard is that its existence would simplify post production management and administration in terms of prepared work statements for post production support. It could be used for either internal of contractual tasking. For example, it would assist movement toward a "best mix" strategy discussed later in functional management.

FIGURE 6
Post Production Support MIL-STD
Possible Topics

Plan
Configuration MGT
Manufacturing Sources MGT
Break-out MGT
Failure Analysis
ECP Analysis
Readiness Analysis - Sensitivities
Corrective Action Analysis
Depot Repair Alternatives: Economics
Tooling, Manufacturing, Test Equipment--
Maintenance Capability
VAMOSC Analysis
Supply Storage
Inventory Control
Etc.

Furthermore, it might be possible to extend its scope to cover interim contractor support (where no such document now exists) and even a MIL-STD for Acquisition Integrated Logistic Support (for which several exist). The proposal, therefore, has considerable appeal from a conceptual viewpoint. The practical feasibility of such a standard is questionable. Discussions of the concept in the visits during the study produced mixed feelings. Since use of such a

standard depends heavily on acceptance, it may be premature to embark on such an effort immediately. However, development of such a standard would probably take several years, so it may be desirable to sponsor some exploratory work to determine with greater certainty the benefits and difficulties with such a standard.

(3) Practice Variance

The wide variance in service Weapon System Management Practice offers opportunity for integration and cross-pollination. It is recommended that DOD undertake a review of such practices. This is not to advocate uniformity, but rather to identify weapon system management approaches and methods which appear suitable for cross-pollination.

The imbalance between system and functional interests in the PPS time frame needs to be corrected. OSD and service PPS focal points are needed to help provide a more even balance. The new policy in development should require such focal points.

(4) Extended Service Life

The rise in system modifications increases the need for PPS engineering services and current or updated configuration management and procurement technical data. One of the surprises uncovered during the contractor visits was the virtually unanimous feeling that configuration management and technical data quality gradually deteriorate over time when program management transfers to or within DOD during PPS. This is particularly true from the reprocurement and redesign aspect. Poor "tech data" impacts virtually all parts of the PPS process. It is a problem when foreign nations come to contractors for support on FMS cases or on items under DOD support management before transfer to allied nations. While some DOD personnel feel this is industry's way of attacking breakout, many DOD personnel privately agree with this industry assessment. A 1978 DSMC study, "Chronic Logistic Support Problems After Transition" (Reference 58 in the bibliography in Appendix C), takes a similar view. The problem is pervasive and multifaceted.

Such needs represent a logical point of departure for the trial PPS programs being undertaken by DOD. It also raises a general issue of continuous vs. sporadic uses of engineering services and updates of data. This issue should be studied to determine if general policy is feasible or if such decisions should be made on a case-by-case basis.

A strong Post Production System Support Improvement ($P^2S^2I$) effort has significant potential to improve readiness and/or lower costs. Historically, "performance" improvement had dominated support (logistic reliability, maintainability parameters, and cost reduction) improvement. A review should be made of current fund distribution. There may be need to "fence" and/or increase $P^2S^2I$ funds. A $P^2S^2I$ initiative is a logical parallel to the logistics R&D effort.

The Air Force PRAM (Productivity, Reliability, Maintainability, and Availability) program is a generic rather than a specific system oriented toward the $P^2S^2I$ type of effort. Such efforts should be initiated by other services. A requirement to do so is in the draft directive.

Less accurate PPS budget estimates on older PPS systems, due to less accurate demand data and pricing data, could result in more budget turbulence, creating inefficiency. This may call for new approaches, such as the one taken in the Minuteman effort discussed earlier. A study should be made to determine the benefits of wider use of the Minuteman or some other approach on a selective basis.

## 3. FUNCTIONAL MANAGEMENT

### (1) Procurement

The DOD data rights problem is due partly to lack of motivation to accurately classify data—or to assign break-out codings (if charged with this task). This suggests the possiblity of an incentive (some extra reward or penalty) for the degree of data rights accuracy and the degree of competitive or direct manufacturer break-out achieved. Contractor achievement could be verified using scientific sampling techniques. This could reduce the DOD workload involved. The feasibility of such an approach is not known. However, in light of the length and magnitude of the problem, further exploration of the concept seems warranted.

Top management emphasis is needed on greater use of multiyear and requirement contracts, and time savings in the PPS procurement process. This potential for savings was discussed in Chapter IV. Current multiyear emphasis is directed toward weapon system contract acquisition. The guidance for use is conservative guidance, e.g., it emphasizes use of multiyear when the strategy is to save money when possibility of loss is minimal. This is probably logical

due to the large amounts of money involved in PPS, where more contracts of smaller value could be involved, a less conservative strategy would probably increase savings achieved. It is recommended that one or more DOD installations involved in PPS procurement be studied to determine the potential for savings through greater use of multiyear and requirement contracts, and the prescreening provisions of the new breakout guidance.

Finally, there is a need for a definitive study of PPS use of competition from a "systems" viewpoint. Chapter IV discussed the fact that, while most of DOD and industry support the principal of competion, there is widespread disillusionment with some aspects of DOD competitive practice. As the Year End Report on the Acquisition Improvement Program notes, competition is a means to an end, not an end in itself. To our knowledge, an examination of the benefits and "costs" of competition has never been conducted from a total "systems" viewpoint. The time has come for such an effort.

(2) Maintenance

Review is needed to ensure conservative transition from interim contractor to organic support wherever possible. OSD should pursue its current plans and actions in this area.

Cost visibility of organic or industry overhaul decisions on major systems should be a requirement in the decision tree under development. OSD should pursue its current plans to require such cost visibility and to review such decisions on major systems.

Longer term studies of alternatives to the present basis for organic overhaul decisions, and the mix of PPS work between DOD and industry should be examined more generally. The results of the Air Force initiative to examine new contract "forms" to overcome current service objections to dependency on contractors for mission essential support, when economics favor the contractor, should be reviewed for possible wider application. A "best mix" approach, as implied by the title (but not the body) of a 1965 LMI Report (Reference 63 in the bibliography in Appendix C), could have significant benefits to DOD. "Best mix" simply implies reorientation of PPS practices to have DOD do what it does "best" and industry do what it does "best."

Such an approach in theory could result in redistribution of the funds currently expended for PPS in a more efficient fashion to achieve greater readiness. For example, savings from more economic spares production rates and multiyear contracting might be used to retain more contractor engineering support to develop R&M improvements (this is impossible now due to funding fences). Savings from use of contractor overhaul, when cheaper, could theoretically be invested in achieving better balance between depot overhaul capability, industrial mobilization requirements, and War Reserve consumables (fuel, bombs, ammunition). A study of the impact of imbalances between the organic overhaul capability, the industrial base, and the levels of war reserve comsumables, and the possibility of considering these elements as a triad to be balanced may also have merit.

(3) DMS

The PPS DMS problem will require continuous attention during the coming years. The current major DOD initiative should be continued. The suggestions made in chapter IV could result in further improvement. $P^2S^2I$ efforts should consider DMS problems as one major point of focus.

(4) Spares

The OSD initiatives to allow long lead time funding for spares, and to allow contractor carrying changes under controllable government/industry support planning agreements have potential payoffs. They should be pursued to completion.

The Economic Order Quantity and Economic Production Rate theories should be reviewed for possible merger. The merged theory should be tested to compare its investment costs and savings as compared to the current theory.

# APPENDIX A

## SITES VISITED AND PERSONNEL INTERVIEWED

## Sites Visited and Personnel Interviewed

| Date of Visit | Organization and Address | Contact |
|---|---|---|
| 07/14/82 | Defense Electronic Supply Center, Dayton, OH | Mr. Bill Smith |
| 07/15/82 | Air Force Logistics Command Headquarters, Wright-Patterson AFB, OH | Mr. Grover Dunn |
| 07/21/82 | Northrop Corporation - Aircraft Division, Hawthorne, CA | Mr. Harold Stormfeltz |
| 07/22/82 | Litton Data Systems, Van Nuys, CA | Mr. Ted Hebrank |
| 07/23/82 | Hughes Aircraft Company - Support Division, Los Angeles, CA | Mr. Ralph Shapiro |
| 07/26/82 | FMC Corporation, San Jose, CA | Mr. Adolf Quilici |
| 07/27/82<br>07/28/82 | Boeing Aerospace Company - Kent Space Center, Kent, WA | Mr. John M. Barker |
| 08/03/82 | Westinghouse Corporation, Hunt Valley, MD | Mr. Richard Drake |
| 08/10/82 | Lockheed Electronics Company, Plainfield, NJ | Mr. Thomas Roberts |
| 08/12/82 | National Security Industrial Association, Washington, DC | Col. Charles H. Curtis |
| 08/17/82 | Aviation Supply Office, Philadelphia, PA | Mr. Robert Powelson |
| 08/18/82 | Warner Robins Air Force Base, Warners Robins Air Force Base, GA | Mr. Raymond McCook |
| 09/13/82 | Navy Ships Parts Control Center, Mechanicsburg, PA | Captain A.J. Morgart |
| 09/27/82 | Headquarters DARCOM, Alexandria, VA | Mr. Dan Washington |
| 10/04/82-<br>10/05/82 | U.S. Army Tank Automatic Command, Warren, MI | Captain Waterman |

## APPENDIX B

## EFFORTS TO IMPROVE READINESS MEASUREMENT, REPORTING, ANALYSIS, AND MANAGEMENT

(Unclassified Portion of the Latest DOD Material Readiness Report to Congress)

## (U) EFFORTS TO IMPROVE READINESS MEASUREMENT, REPORTING, ANALYSIS, AND MANAGEMENT

(U) OSD: To emphasize the importance that this Administration places on military readiness in our overall defense priorities, three important organizational changes have been made within the Office of the Assistant Secretary of Defense (MRA&L): A new office -- the Directorrate of Force Readiness/Sustainability Requirements and Analyses -- has been establishd as MRA&L's principal "advocate" for force readiness in all aspects of the DOD's planning, programming, and budgeting processes. This new Directorate will also structure and oversee a comprehensive research program to develop analytical tools that relate resources to force readiness. Second, the Reserve Affairs Readiness Directorate has been reactivated, after having been disestablished in 1976. Third, the Manpower Planning and Analysis Directorate has been expanded to consolidate a wider range of manpower and personnel activities, with special emphasis on force readiness.

(U) OSD is working with the Services to implement changes in PPB data systems to provide better visibility of the budgetary resources affecting readiness -- especially thereadiness of our principal weapons systems. OSD is also working with the services and with DLA toward shifting secondary item management from a supply system availability orientation to a weapons system availability orientation.

(U) A currently ongoing OSD-sponsored research effort is developing the capability to estimate both the peacetime readiness and wartime sustainability of Army firepower and maneuver units as a function of 11 classes of resources, including weapons, crews, support personnel, tools, support equipment, spares, munitions, and fuel. The next major goal of this research is to refine and "package" the products developed to date into an integrated methodology that can be used by Army and OSD analysts during the preparation and review of programs and budgets. OSD is also co-sponsoring a research effort with the Navy and Air Force to build an aviation materiel readiness model that will be much more detailed and comprehensive than currently-existing models of this type. Its construction will allow it to be used for a wide variety of purposes and at various levels of detail. Obvious advantages should accrue from the ability to use a common modeling approach in varied-but-related readiness analyses. Another OSD project is aimed at developing indicators of the ability of the wholesale logistics system to transition to, and sustain, the increased workload required to support our forces under combat or crisis conditions. Finally, OSD is beginning a series of research efforts to in-

vestigate the relationship between resources and personnel readiness.

(U) OSD will conduct a Resources-To-Materiel-Readiness Modeling Symposium during the fourth quarter of FY 1982. This symposium will bring together readiness analysts and managers from DOD, academia, research firms, and industry to exchange information and ideas and facilitate future progress in readiness measurement, reporting, analysis, and management.

(U) Army: Some Army efforts aimed at improvements in the readiness arena are summarized below:

- The Army seeks to achieve balance among the "four pillars of capability" -- readiness, sustainability, force structure, and modernization -- via its annual Macro Analysis of Force Alternatives and resulting Army Plan.

- The Army Logistics Assessment (ALA) illuminates shortfalls limiting the Army's ability to respond to crisis situations. ALA is used in fine-tuning and balancing programming and budgeting allocations.

- The U.S. Army Operational Readiness Analysis (OMNIBUS) assesses readiness elements within the context of total force capability, and provides insights into the effects of various levels of readiness on the mobilization, deployment warfighting, and (in conjunction with ALA) sustaining capabilities of the Army. OMNIBUS results are useful in program and budget development and budget execution.

- Implementation of the Army's Training Management Control System (TMACS) will help unit commanders evaluate resource impacts on training plans and record training accomplished and resources expended. TMACS is designed to be operated by soldiers without specialized computer backgrounds.

- The Army is examining the feasibility/desirability of merging data from its Total Army Equipment Distribution Plan, Unit Status Reporting System, and Force Accounting System to achieve a better perspective on problems involving equipment inventories and condition status.

- The Army's pacing item a/ list has been expanded to include items for Combat Service Support (CSS)

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a/ A pacing item is one that is indispensible to the performance of a unit's mission.

units, and additional items for Combat Support units. The list now includes more than 50 pacing items. In addition to equipment such as tanks, missiles, and armored personnel carriers, the list includes items of equipment critical to the mission of chemical, engineer, signal, transportation, maintenance, medical, aviation and supply units.

- The Army is conducting a study of the different reporting systems used to assess the materiel condition status of various equipment types, e.g., aircraft, missiles, ground equipment. The study objective is to recommend means for achieving simplification, standardization, and efficiency across these various systems.

(U) Navy: Among the Navy's continuing efforts to relate resources to readiness are the following:

- Development of a method of computing peacetime readiness (and wartime sustainability) for Naval aviation as a function of spares, POL, munitions, and required activity levels.

- Under the direction of the Naval Material Command, a system for determining ship readiness, similar to the aircraft Subsystem Capability Impact Reporting (SCIR) system, is being developed.

- The Navy has improved its Unit Status and Identity Reporting (UNITREP) system through a series of detailed logic/mission diagrams. During FY 1982 the Center for Naval Analyses will undertake a study to determine what UNITREP enhancements are needed and possible to enable the system to be compatible with resource-to-readiness concepts.

- The Navy has developed and is using a data base system that tracks all funds affecting readiness. The system (which tracks back to 1974) allows consistent definition and provides insight into dollar flows. It has been used in some preliminary resource-to-readiness modeling.

- The Navy staff has developed relationships between resources and MC rates for aircraft. The technology is still being verified, but appears to be promising. Work is also proceeding on developing relationships between UNITREP personnel ratings and initiatives such as pay, allowances, quality of life improvements, and civil sector unemployment rates.

- The Navy is developing a UNITREP-like system for its bases. The system uses a "C-rating" system for facilities, equipment, military, and civilian personnel. Tes-

ting of the system, begun in FY 1981, will continue in FY 1982.

(U) Air Force: The Air Force's Logistics Capability Measurement System (LCMS) uses the Aircraft Availability Model (AAM) to relate spares and depot maintenance funding to the percentage of aircraft, by type, not awaiting parts during peacetime operation. The LCMS Overview model relates funding for spares, maintenance, POL, and munitions to the number of sorties, by type of aircraft, that can be flown under various scenarios. Over the past several years, both the AAM and the Overview model have proved to be very powerful tools in the preparation and review of the Air Force budget and Five-Year Defense Program. These models have also been used for some budget execution decisions.

(U) The Air Force is continuing development of its Integrated Readiness Management System (AFIRMS). An analysis has been completed of the information requirements for readiness measurement and management at all levels of the Air Force. This information will be used to build a working prototype of a computer-based, interactive, decision-support system during FY 1982. One or two tactical air wings will be used in this prototype, and the knowledge gained in building and experimenting with the prototype will be used in designing and building the final system, which will cover all aircraft types and missions.

(U) Marine Corps: Marine Corps initiatives in the materiel readiness area include the following:

- The Marine Corps is reviewing its Automated Readiness Evaluation System (MARES) to: (1) find the gaps in materiel readiness reporting and data collection systems, (2) develop information required by decision makers at all levels for resource allocation and planning, and (3) define associated data elements for inclusion in emerging data base management systems.

- An automated reporting system that stratifies in-stores assets against prioritized requirements has been developed as a part of the redesign of the Marine Corps War Reserve System. This system improves the Marine Corps' ability to measure materiel readinesss (and sustainability) relative to specific operations plans (OPLANS).

- The Marine Corps Integrated Maintenance Management System (MIMMS) is being improved through continuous refinement of program design and application. The MIMMS data base will support life cycle cost and readiness analyses.

(U) Marine Corps initiatives in the area of personnel readiness include the following:

- The Marine Corps is currently implementing or developing numerous systems/programs to improve manpower management and associated readiness. The Real Time Finance and Manpower Management Information System (REAL FAMMIS) will provide a single, centralized automated pay and manpower management system, accessible by authorized users at all echelons.

- The Precise Personnel Assignment System (PREPAS), a systems approach to the training and assignment of enlisted personnel, is designed to reduce personnel turbulence, improve the use of manpower, and attain the highest level of readiness possible from that total available manpower.

- The recently-implemented Manpower Program and Budget Development Process provides a standardized process for rapidly determining detailed manpower requirements by grade and skill. This process enables the Marine Corps to address current and future critical skill shortages better through early identification and action.

- The Unit Deployment Program, in the last stages of implementation, has been very successful in stabilizing deployed units, thus improving unit cohesiveness and morale as well as readiness.

(U) Marine Corps initiatives in the training readiness area include the following:

- In November 1981 the Commandant of the Marine Corps established a separate Training Department on the Headquarters staff to provide more effective management of Marine Corps training. Additionally, a forthcoming Marine Corps order will assign functional control of specified Marine Corps formal schools and academic supervision of training centers to the Commanding General, Marine Corps Development and Education Command, to provide more effective and efficient management of training institutions.

- The Marine Corps has adopted a performance-oriented training management system based on individual and collective training standards. The first set of Individual Training Standards (ITS), for the infantry occupational field, was completed and distributed during 1981. The ITS system will provide: common training standards by grade and occupational field; a listing of training references, training support, ammunition requirements, and correspondence courses to support each training standard; and a means to conduct an internal diagnostic

evaluation of training conducted. The individual tasks of the ITS system complement the collective training standards of the Marine Corps Combat Readiness Evaluation system described in the following paragraph.

(U) The ultimate objective of all the systems for the management of equipment, personnel and training readiness is the overall combat readiness of the Fleet Marine Forces (FMF). To this end, the Marine Corps Combat Readiness Evaluation System (MCCRES) provides for the timely and accurate determination of the combat readiness of FMF units, including those of the Marine Corps Reserve, to accomplish assigned missions. MCCCRES provides standardized evaluation policies and procedures and a comprehensive definition of standards for mission performance.

# APPENDIX C

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# APPENDIX D

# DRAFT POLICY DIRECTIVE

ASD(MRA&L)

# DEPARTMENT OF DEFENSE DIRECTIVE

SUBJECT: Post Production Support Management for Systems and Equipment

REFERENCES: (a) "Acquisition and Management of Integrated Logistic Support for Systems and Equipment," January 17 1980 (hereby cancelled)
(b) DoD Directive 5000.1, "Major System Acquisitions," March 29, 1980
(c) DoD Instruction 5000.2, "Major System Acquisition Procedures,"
(d) through (r), see enclosure 1

## A. PURPOSE

This Directive establishes policy and responsibilities for Integrated Logistics Support (ILS) Programs as an inherent part of the Post Production Management of systems and equipment to meet readiness thresholds within established cost, schedule, and logistics contraints.

## B. APPLICABILITY AND SCOPE

1. This Directive applies to the Office of the Secretary of Defense, the Military Departments, and the Defense Agencies (hereafter referred to as "DoD Components") for major system acquisitions (references (b) and (c)), including single component, multi-component and international acquisitions.

2. This Directive provides guidance for DoD Components when establishing policy for ILS of less-than-major systems and equipment.

## C. DEFINITIONS

1. Integrated Logistic Support (ILS). A unified and iterative approach to the management and technical activities necessary to: (a) cause support considerations to influence requirements and designs; (b) define support requirements (including manpower personnel and training) that are consistently related to the design and to each other; (c) acquire the required support; and (d) provide and manage the required support during the operational phase at minimum cost.

2. Additional terms used in this Directive are defined in Enclosure 2.

D. POLICY

1. Progra: Management

a. General

(1) System readiness is a primary objective of post production process. Resources to achieve readiness shall receive the same emphasis as those required to achieve schedule objectives throughout a systems life cycle.

(2) Systems and equipment shall have a post production ILS program that begins no later than the POM year when the last year of production becomes a POM issue, and continues throughout the post production phase. It shall be structured to meet program system readiness goals within established cost, schedule, and logistics constraints.

(3) Realistic post production peace time and war time readiness thresholds shall be established prior to production phaseout and used as a principal management tool. The approach to achieving these thresholds shall be included in the post production ILS plan with explicit programming and resources to achieve them. Readiness goals will be defined in such a way that they can be quantitatively related to

measureable hardware R&M characteristics, and to logistics resource requirements (manpower, spares, test equipment, etc.).

(4) The scope and level of the post production ILS program (including data requirements) shall be tailored to meet the specific needs of the program during post production. Enclosure 3 lists essential post production ILS considerations.

b. <u>Basis for Post production ILS Planning and Resource Decisions</u>

(1) Early post production ILS planning shall be based on the following:

(a) Logistics and affordability constraints.

(b) The system operation concept and system readiness objectives.

(c) Realistic estimates of system and subsystem R&M and other parameters which drive manpower and other logistics demands.

(d) Assessment of risk based on the sensitivity to uncertainty in key design and logistics parameters.

(e) Documented post production ILS analyses which quantitatively link design parameters and ILS requirements to system readiness thresholds and define detailed support element requirements.

(f) Review and assessment, when appropriate, of alternative strategies to support the operational requirement for the system at the lowest life cycle cost.

(g) Established obsolescence milestones, including a target date for striking the system or equipment from the inventory.

(h) Anticipated changes in the production and technology base.

(i) Preplanned product improvements.

(2) Post Production ILS planning for resource decisions shall be based on the following:

(a) Budget and manpower requirements directly traceable to system readiness thresholds and the latest estimates of initial and mature R&M Values. They shall be updated using operational experience as it becomes available.

(b) Full consideration of current maintenance, provisioning, and supply support policies, systems, capabilities, and procedures (DoD Directives 4151.1, 4151.16, and 4140.40 and DoD Instructions 4151.11, 4151.12, 4151.15, and 4140.41 (references (d) through (j)). Innovative support concepts to improve system readiness and support costs are encouraged. Proposed support concepts shall balance the most effective approach from the program view with the needs of the support structure. A summary of the rationale for the proposed concepts shall be documented in the ILS post production plan.

c. Post Production Support Analysis (PPSA).

(1) PPSA shall include appropriate field experience, analytical tools and models, engineering and field test data which shall be used throughout the post production cycle to evaluate alternative support concepts, identify technological opportunities to perform tradeoffs between system design improvement and ILS elements, and to perform tradeoffs among ILS elements in order to meet system readiness objectives at minimum cost.

(2) PPSA shall be used to effect system design improvement, integration of support planning and consistency among ILS elements. Post Production ILS analysis shall commence at program initiation and be consistent with and based on analyses performed during acquisition.

(3) Clearly defined systems engineering procedures (such as Reliability Centered Maintenance) shall be implemented to influence the evolving system design improvements and to determine ILS element requirements.

(4) R&M parameters shall be defined in terms consistent with data collection on fielded equipment. Estimates of R&M parameters shall reflect anticipated maintenance demands for the system in the field. These estimates shall be maintained in a consistent, common data base and used to support both ILS analysis and R&M improvement efforts.

d. Program Management

(1) The in-service program manager is responsible for post production ILS. The program manager shall be supported by a qualified ILS manager, to serve as the program focal point for logistic planning, analyses relating ILS elements to system readiness goals, the support-related design improvement interface, and operating and support (O&S) costs. For multi-component support programs, each participating DoD Component shall designate a qualified post production ILS manager to participate in ILS management under the program manager. A continuing interface between the program management office and the logistic communities shall be maintained.

(2) The in-service program manager shall have a current post production ILS plan to support program decisions. The ILS plan shall identify readiness, and other support goals and demonstrated achievements; define support concepts, plans, and ILS issues; and document ILS element requirements, schedules, funding requirements, and responsibilities for ILS activity planned for the succeeding program phases. In multi-component acquisition programs, the post production ILS plan shall address the support requirements of all participating components.

(3) In-service program budgets shall include adequate funding for post production ILS planning, analysis, and cost reduction efforts. Budgets for redesign shall include adequate test hardware to verify R&M impact.

(4) Innovative contractor efforts to improve support related design features and reduce support requirements shall be solicited, and contractor support shall be used when it is feasible and beneficial to the Government due to readiness and economics.

(5) Positive controls (such as network scheduling systems, WBS) shall be established to integrate schedules and to identify interdependencies among the ILS elements, and redesign activities.

(6) ILS management information (including details of schedule, resource levels and estimates, PPSA record, and status of progress toward support-related thresholds) shall be current and available to support ILS planning and management decisions. Duplicate data bases and reporting requirements shall be avoided. Standard data elements shall be developed and used to the extent possible.

(7) The in-service program manager shall have sufficient visibility of support resource allocations and budgets to effectively coordinate on changes that affect program plans. A clear "audit trail" of changes in support budgets, support related goals and thresholds (including changes in definitions), and their impact on system readiness goals, support costs, and support schedule objectives shall be maintained.

(8) Periodic readiness assessments shall be conducted, and readiness plans developed to address any readiness deficiencies.

(9) Plans for post-deployment support of software and related computer resources shall be periodically updated. These plans shall include resources requirements, milestones, responsibilities, and acquisition strategies for making software design and support improvements needed to meet system readiness and effectiveness goals.

e. Test and Evaluation. Appropriate T&E to assess supportability will be conducted on post production design changes.

2. Management Support Requirement: DoD Components shall establish and maintain a program which sponsors improvements to generic post production support productivity and readiness problems.

E. RESPONSIBILITIES

1. The Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics) shall:

a. Issue policies and guidance on post production ILS.

b. Review readiness objectives for realism, consistency with design, and supportability.

c. Review post production ILS plans (including post production support) and resources for adequacy.

d. Review programmed logistic resources for fielded systems for consistency with readiness goals and compatibility with field experience.

The Secretaries of Military Departments and Directors of the Defense shall:

a. Implement the policies of this Directive for major system programs.

b. Develop policies for the application of post production ILS to less-than-major programs.

c. Establish a Component focal point for post production ILS policy.

d. Insure that each major program has representation and participation of functional elements responsible for the programming, funding, acquisition and application of operational system support resources.

e. Conduct post production readiness analyses.

f. Include adequate post production funding in budget submission and identify the readiness impacts of funding shortfalls.

g. Conduct ILS reviews during post production to assess, in quantitative terms, the adequacy of Post Production Support

plans), resources, and support-related parameters to meet system goals.

h. Designate a focal point for each program that will maintain and update post production ILS analysis data as required for the life of the system.

i. Insure that field logistics data collection systems provide adequate data for comparative analysis of field experience with the systems ILS analysis data base and for use in developing new annual systems and equipment.

5. <u>In-service Program Managers shall</u>:

a. Include post production ILS as an integral part of their program.

b. Allocate appropriate engineering support resources and schedule for ILS, including post production ILS requirements of participating DoD Components in multi-component acquisition programs.

c. Structure management strategy to address opportunities to reduce logistics risk.

d. Balance system readiness with cost and schedule goals.

e. Advise the Component Head and Defense Acquisition Executive on projected shortfalls or impediments to meeting system readiness goals.

## F. EFFECTIVE DATA AND IMPLEMENTATION

This Directive is effective immediately. Forward two copies of implementing instructions to the Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics) within 120 days.

REFERENCES, continued


(d) DoD Directive 4151.1, "Use of Contractor and Government Requirement for Maintenance of Materiel," June 20, 1970

(e) DoD Directive 4151.16, "DoD Equipment Maintenance Program" August 31, 1972

(f) DoD Directive 4140.40, "Basic Objectives and Policies on Provisioning of End Items of Materiel," February 20, 1973

(g) DoD Instruction 4151.11, "Policy Governing Contracting for Equipment Maintenance Support," June 11, 1973

(h) DoD Instruction 4151.12, "Policies Governing Maintenance Engineering Within the Department of Defense," June 19, 1968

(i) DoD Instruction 4151.15, "Depot Maintenance Programming Policies," November 22, 1976

(j) DoD Instruction 4140.42, "Determination of Initial requirements for Secondary Item Spare and Repair Parts," August 7, 1974

(k) MIL-STD 1388A, "Logistic Support Analysis"

(l) DoD Instruction 5000.33, "Uniform Badget/Cost Terms and Definitions," August 15, 1977

(m) DoD Directive 5010.2C, "Work Breakdown Structures for Defense Materiel Items," July 31, 1968

(n) MIL-STD 881A, "Work Breakdown Structures for Defense Materiel Items," April 25, 1975

(o) DoD Directive 5000.3, "Test and Evaluation," December 26, 1979

(p) DoD Directive 5000.19, "Policies for the Management and Control of Information Requirements," March 12, 1976

(q) DoD Directive 5000.11, "Data Elements and Data Codes Standardization Program," December 7, 1964

(r) DoD Instruction 4120.19, "Department of Defense Parts Control System," December 16, 1976

(s) This list will require modification.

## ADDITIONAL DEFINITIONS

1. The ILS Elements are:

a. Maintenance Concept. The description of the maintenance requirements for a material system. Post Production Support Analysis (Ref ) is utilized to provide a structured approach for determining the specific maintenance requirements of the system.

b. Manpower and personnel. The identification and acquisition of military and civilian personnel of the required skill level and grade required to operate and support a materiel system, at peacetime activity and war time rates.

c. Supply support. All management actions, procedures, and techniques required to determine, acquire, catalog, receive, store, transfer, issue, and dispose of principal and secondary items. It includes provisioning for initial support as well as replenishment supply support.

d. Support equipment and test equipment. All equipment (mobile or fixed) required to support the operation and maintenance of a materiel system. This includes associated

multiuse end items, ground handling and maintenance equipment, tools, metrology and calibration equipment, communications resources, test equipment and automatic test equipment (ATE), with diagnostic software for both on and off equipment maintenance. It includes the acquisition of support for the support and test equipment itself.

e. Technical data. The communications link between people and equipment. It includes all types of specifications, standards, engineering drawings, task analysis instructions, Data Item Descriptions (DID) reports, equipment publications, tabular data, and test results used in the development, production, testing, use, maintenance, and disposal of military items, equipment, and systems. Computer programs and related software are not technical data; documentation of computer programs and related software are. Also excluded are financial data or other information related to contract administration.

f. Training and training devices. The processes, procedures, techniques, and equipment used to train personnel to operate and support a materiel system. This includes individual and crew training, new equipment training, and logistic support for the training devices themselves.

g. Computer resources support. The facilities, hardware, software, and manpower needed to operate and support embedded computer systems.

h. Facilities. The permanent or semipermanent real property assets required to support the materiel system, including conducting studies to define types of facilities or facility improvements, locations, space needs, environmental requirements, and equipment.

i. Packaging, handling, storage and transportation. The resources, requirements, specifications, design considerations and methods for preserving, transporting, and storing systems, equipment and supplies. This includes: (a) procedure, environmental considerations, and equipment preservation requirements for short and long term storage; and (b) the necessary actions to insure systems are transportable, in,available, or projected transportation assets.

2. Post Production Support Management. The management program executed to insure attainment of system readiness objectives with economical logistic support after cessation of production of the major end item (weapon system or equipment). Planning for post production support begins no later than in the POM year when the last year of production becomes a POM issue.

3. Support Acquisition Costs. Selected development and procurement costs (reference (1)) associated with a weapon system during the acquisition phase that are required to insure that planned support of the weapon system is achieved.

4. <u>Weapon System and Equipment Support Analysis</u>. The selective application of scientific and engineering efforts undertaken during the acquisition process, as part of the systems engineering process, to assist in (a) causing support consideration to influence design, (b) define support requirements that are optimally related to design and to each other, (c) acquire the required support, and (d) provide the required support during the operational phase at minimum cost.

# SUPPORT CONSIDERATIONS IN THE POST PRODUCTION PROCESS

The following are post production ILS considerations:

1. Post Production Support Planning Survey - prior to End of Item Production Cessation.

(a) A detailed plan for post production support has been prepared.

(b) Field experience in readiness, R&M and logistics support have been evaluated and logistics resources adjusted.

(c) Alternative post production support concepts and related acquisition strategies (including by out, sustained production, competitive industrial base maintenance, organic versus contractor support) have been evaluated.

(d) Projected obsolescence dates, modifications and life extension programs have been identified.

(e) System support and readiness analysis responsibilities for the follow on phase have been identified.

2. <u>Post Production Support - Beginning with the end of production</u>.

(a) Security Assistance and FMS considerations have been identified.

(b) Procedures for informing industry of forthcoming program support activities have been developed or are in development.

(c) Provisions for maintaining current configuration and technical data are planned.

(d) $P^3I$ plans are incorporated into the post production support plan.

(e) Peacetime and wartime readiness goals are current.

(f) Post production support plans, budgets, and associated resources are tied to system readiness goals. This includes manpower requirements.

(g) Post production support budgets include funds for planning, for analysis (failure or deficiency and readiness), and cost reduction efforts during post production.

(h) Plans have begun for periodic (annual) readiness assessments, using appropriate analytical tools such as system simulations, to insure a "systems" as well as ILS element approach for improvement or corrective actions.

# APPENDIX E

## A "REAL-WORD" LOOK AT RMA VS. COST

# A "REAL-WORLD" LOOK AT RMA VS. COST

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# A "REAL-WORLD" LOOK AT RMA VS. COST

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## ABSTRACT

Operating and support costs are an ever-increasing percentage of the life cycle costs of complex military systems. Most such costs are incurred in response to meeting some specified measures of system reliability, maintainability, and availability (RMA). When an operational weapon system fails to meet its specified operational availability ($A_O$), the acquisition manager must decide how to spend his money to meet the specified requirements: Does he increase reliability, maintainability, level of logistics support, or all three? How does he make these improvements? Moreover, how does the acquisition manager measure what he's getting for his money? To answer these questions for the Mk 86 gun fire control system, Lockheed and the Navy engaged in a series of analyses:

(1) Since the Mk 86 is a multi-mission system, $A_O$ was recalculated for each mission.

(2) Mathematical analyses were performed of the sensitivity of $A_O$ to the various components that make it up.

(3) A "worst case" analysis was conducted for each mission to assess both the $A_O$ and the probability of mission success for various mission times.

The above analyses enabled the Navy to, first, provide a set of tools for measuring how much combat readiness the Mk 86 really had; second, establish goals for each mission for the level of readiness really required; and third, evaluate the potential cost effectiveness of various reliability and logistics improvements to the system.

## INTRODUCTION: THE MK 86 READINESS PROBLEM

A recent trend in the surface Navy is to measure weapon system reliability, maintainability, and availability (RMA) in terms of the probability that a system will (1) be available at the start of a particular mission and (2) continue to operate for the duration of the mission. This approach to RMA addresses the persistent problem of how to measure the operational readiness of a shipboard weapon system in a way that realistically assesses combat readiness. It evolved, in part, from the Navy's experience with LEC's Mk 86 gun fire control system.

This paper presents a study of the RMA program history of the Mk 86 system. It reveals the inadequacies of earlier Mk 86 RMA assessments and discusses some new RMA approaches to the Mk 86. This paper then describes the specific analytical efforts directed at improving the availability of the 60 Mk 86 weapon control systems procured for the most modern ship classes in the Fleet, including DD 963s, LHAs, CGNs, and CG 47s (Aegis ships).

Most RMA assessments of shipboard equipment are measured in terms of operational availability ($A_o$), mean time between failures (MTBF), and mean down time (MDT), which is controlled primarily by mean logistics time per failure. Over the time period shown on Figure 1, the measured reliability (expressed in terms of MTBF) and operational availability ($A_o$) of the Mk 86, as reported by the Fleet Analysis Center (FLTAC) and Naval Ship Weapon Systems Engineering Station (NSWSES), were steadily improving, although mean logistics time did not change noticeably. Yet, the reports from the Fleet of failures during test operations and extended downtimes did not indicate, when viewed subjectively, the marked improvement suggested by the Navy's own figures.

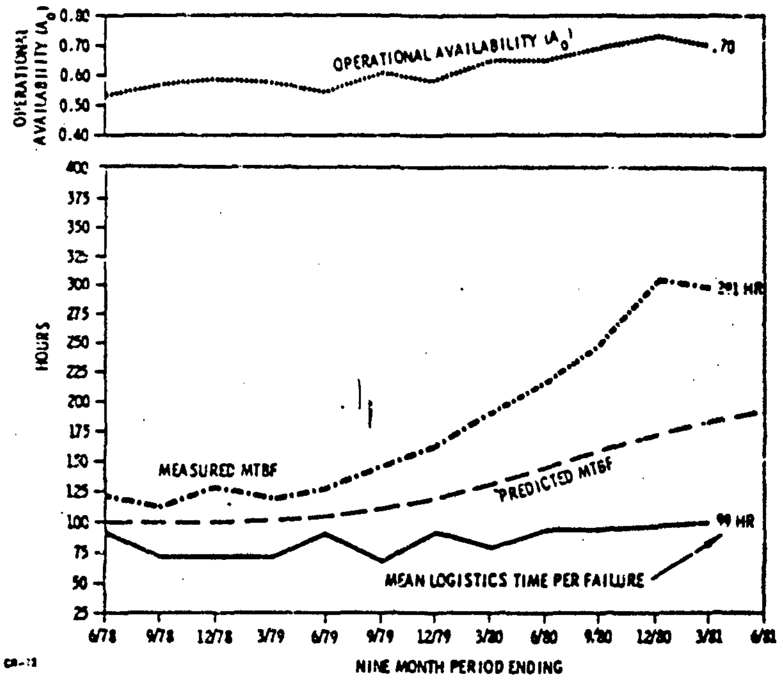


Figure 1. Mk 86 Readiness Trends

Why was the RMA data compiled by the Navy apparently at odds with the actual performance of the Mk 86? Working in conjunction with Lockheed Electronics Company, the Navy concluded that its existing RMA assessment methods were insufficient and began searching for new methods that would more realistically indicate the system's combat readiness.

MK 86 PROGRAM BACKGROUND

To understand why the Navy's past RMA-assessment methods fell short of their mark, it is necessary to understand some of the background of the Mk 86 program. The Mk 86 today is a sophisticated system designed to combat surface, shore, and air targets. It combines a general-purpose digital computer and proven software modules to control a variety of weapons, including as many as three 5-inch guns. The Mk 86 can operate with the ship's guided missile systems to control semi-active homing surface-to-air missiles, such as Standard

Missiles (SM-1) on ships equipped with the Tartar system. A typical system, as shown in Figure 2, consists of five functional groups:

- A high resolution, surface/low-flyer search and track-while-scan radar (AN/SPQ-9) capable of automatically tracking up to four selected targets.
- An air-tracking radar (AN/SPG-60) capable of both low and high-altitude tracking.
- An optical sensor system using either one, two, or three remote optical sights (ROS) to supply camera video for display on monitors.
- A general-purpose digital computing system capable of generating simultaneous orders for multiple weapons.
- Operator display consoles which include radar controls and read-outs, weapon status monitoring, automatic tracking, and target parameters.

Operational availability of the Mk 86, as defined by the Navy, is the ratio of a system's up-time to total time (up-time plus down-time). The Specific Operational Requirement (SOR) for the Mk 86 included an operational availability goal that the system be operable and ready to fire 90 percent of the time, including logistic factors. This goal was incorporated as a desirable feature of the Mk 86 but not imposed as a requirement. The goal was set at a time when RMA disciplines were not always given the same attention they receive today. Moreover, it would have been difficult to impose such a goal as a design requirement because factors other than system design enter into the $A_o$ equation. These factors, which the design contractor cannot control, include Navy sparing and spare parts stocking criteria, competence of maintenance personnel, adequacy of training and publications, and effectiveness of administrative procedures, test equipment, and support services.

The Navy had also specified that Lockheed must build the Mk 86 system to specifications that would meet the following RMA baseline conditions:

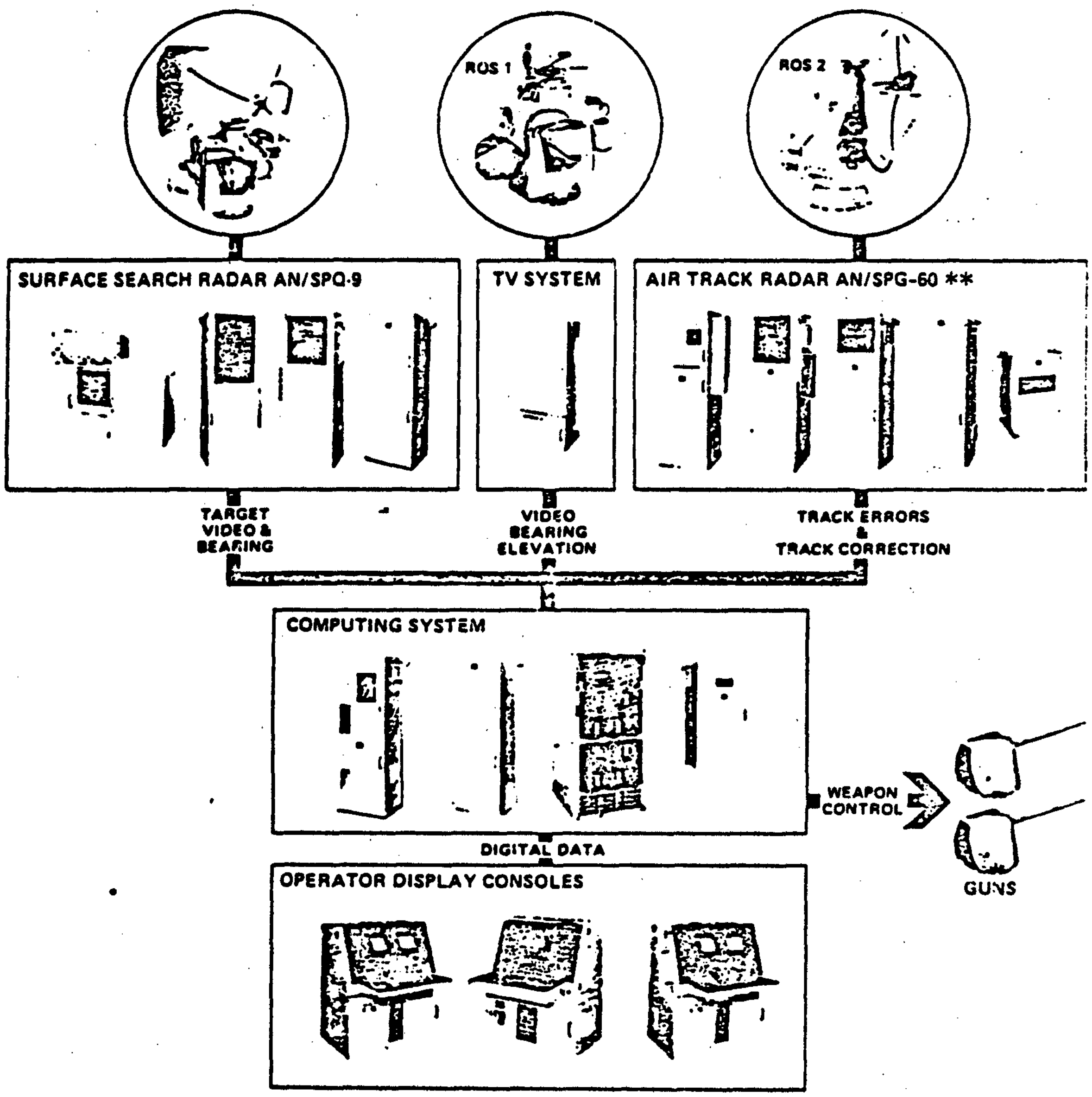


Figure 2. Gun Fire Control System Mk 86

- MTBF of 100 hours for the system
- MTBF of 300 hours for each of the major functional groups

(The general-purpose digital computer, which was government-furnished equipment, was not included in the MTBF requirements.) The system MTBF requirement was met during operational evaluation (OPEVAL) and has been exceeded continually since the system was deployed.

MEASURING MK 86 RMA

Reliability, maintainability, and operational availability ($A_o$) for the Mk 86 are monitored by the Naval Ship Weapon Systems Engineering Station (NSWSES), Port Hueneme, California, using the equation shown below:

$$A_o = \frac{MTBF}{MTBF + MDT} = \frac{MTBF}{MTBF + MTTR + MLTPF + MOHAT}$$

| | | | |
|---|---|---|---|
| where | $A_o$ | = | Operational Availability |
| | MTBF | = | Mean Time Between Failures |
| | MDT | = | Mean Down Time (MTTR + MLTPF + MOHAT) |
| | MTTR | = | Mean Time To Repair |
| | MLTPF | = | Mean Logistics Time Per Failure |
| | MOHAT | = | Mean Outside Help and Administrative Time |

To obtain the 0.90 goal for $A_o$, with the specified system MTBF of 100 hours, the mean down time cannot exceed 11 hours. The nomograph of Figure 3 graphically shows the relationships between MTBF and the MDT components. The dotted line shows the specified MTBF of 100 hours, the operational availability goal of 0.90, and the required MDT of 11 hours. Notice that the system MTBF for the Mk 86 is approximately three times higher than the required figure of 100

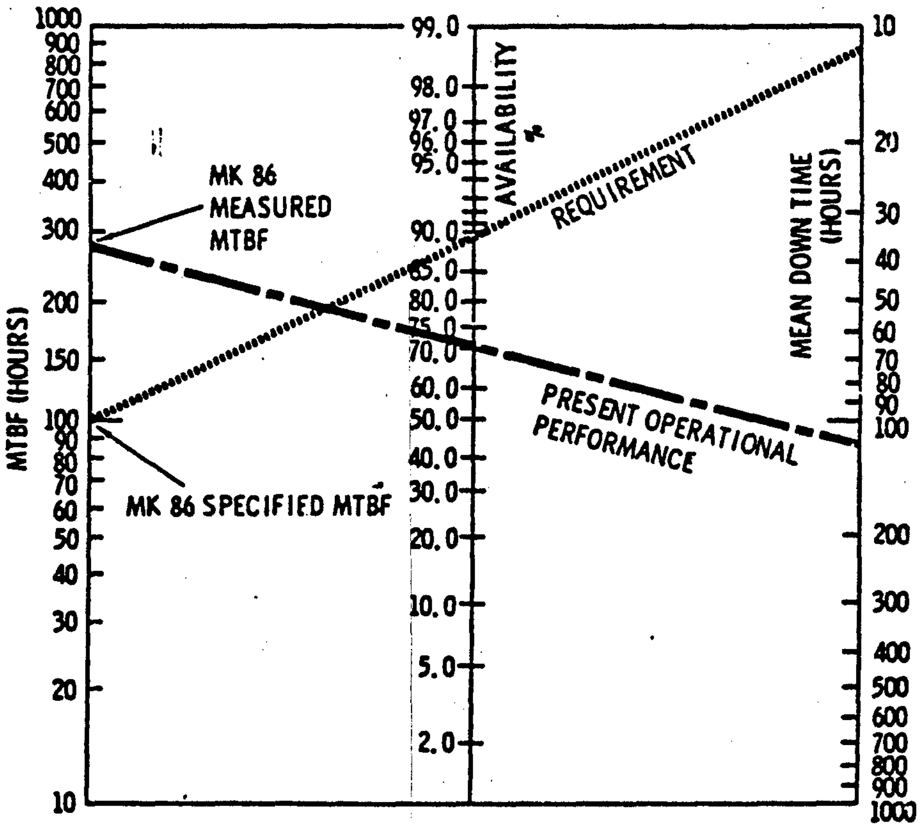


Figure 3. Factors Affecting Operational Availability

hours, but that mean down time is significantly higher than 11 hours. This situation results from the repair philosophy for modern complex shipboard weapons systems, which specifies modular replacement aboard ship and modular repair at depots. The problem is that it takes as long as two weeks to get a module that is not stored on-board a ship. By Navy criteria, if a module has a predicted failure rate of 1 in 10,000 hours and a shipboard population of one, it will not be provisioned as a shipboard part. Since only about 75 percent of Mk 86 replaceable modules are stored aboard ship, and two requisitions a year off ship can drop availability to below 90 percent, the 90 percent requirement was clearly unrealistic. Note that the 100 hours mean down time achieved by the Mk 86 is exceptional; the Navy considers 200 hours more typical of modular shipboard systems.

After a few years of operational deployment and some preliminary analyses, it became clear, first, that the Mk 86 would not reach its availability goals and, second, the goals themselves did not assess combat readiness.

It looked as though there were several problems with the way the Navy had specified Mk 86 readiness:

- First, the basic requirement was unrealistic in that the way the Navy supply system operates was not considered. How can we specify 90 percent availability and 100 hours MTBF if we accept 100 to 200 hours mean down time per failure?
- Second, it was misleading, in that it specified an overall figure for the system without taking into account its multiple missions. The Mk 86 has four missions: direct and indirect shore bombardment, surface fire, and antiaircraft warfare. What is the point of saying we have a .70 availability if we don't know the availability for each mission?
- Third, it asked the wrong question. It measured the amount of time the system was down or up, not whether or not it would be up when it was needed. What we really wanted to know was:

"What is the probability of the system's being up at the start of a particular mission engagement and remaining up for the duration of the mission?"

## MK 86 RMA ANALYSES

As a first step in answering "real questions," we began to analyze the data by missions. The four basic Mk 86 missions (as shown in Figures 4 through 7) use distinct portions of the system, and none of the four uses the entire system. More important, both radars are never used in the same mission.

As a result of this approach, the Navy issued a revised SOR for the Mk 86, which specified a goal of 0.90 for each mission and a threshold of 0.80 for each mission except air target, which was reduced to 0.70, since it is a secondary mission for the Mk 86. In addition, reliability was specified by mission, with a goal of 200 hours MTBF for each mission and a threshold of 160 hours, except for air target, where the goal was set at 180 hours and the threshold at 150 hours. The revised requirements are shown below:

TABLE I

UPDATED MK 86 READINESS REQUIREMENTS BY MISSION

Change No. 1 to SOR 12-04R3, dated 11 May 81, establishes the following:

| MISSION | THRESHOLD | | GOAL | |
|---|---|---|---|---|
| | $A_o$ | MTBF (HR) | $A_o$ | MTBF (HR) |
| Naval Gun Fire Support (Indirect) | .8 | 160 | .9 | 200 |
| Naval Gun Fire Support (Direct) | .8 | 160 | .9 | 200 |
| Surface Targets | .8 | 160 | .9 | 200 |
| Air Targets | .7 | 150 | .9 | 180 |

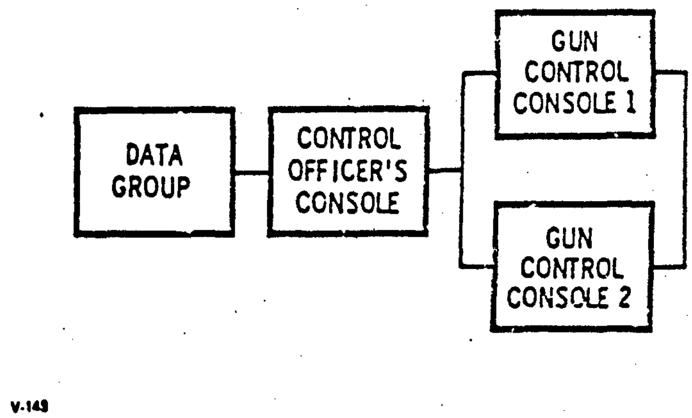


Figure 4. RMA Block Diagram of GFCS Mk 86: Indirect Naval Gun Fire Support

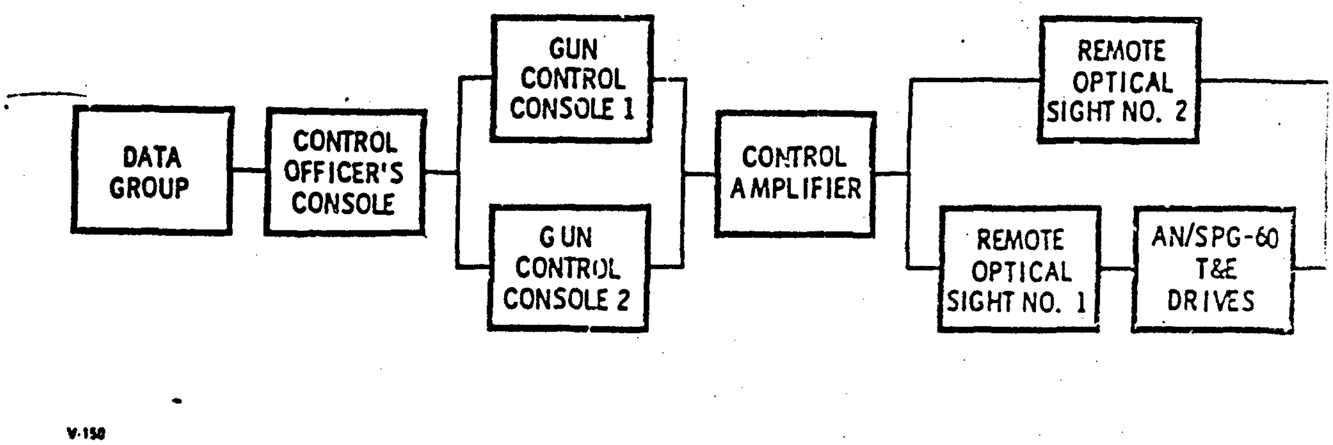


Figure 5. RMA Block Diagram of GFCS Mk 86: Direct Naval Gun Fire Support

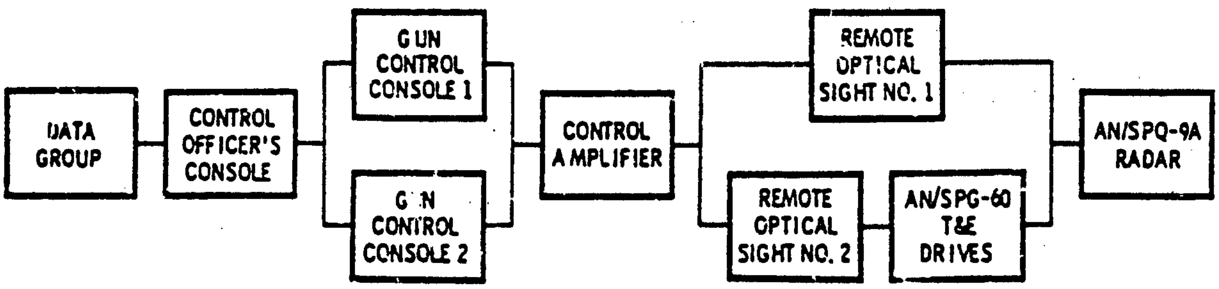


Figure 6. RMA Block Diagram of GFCS Mk 86: Full Surface Mode Capability

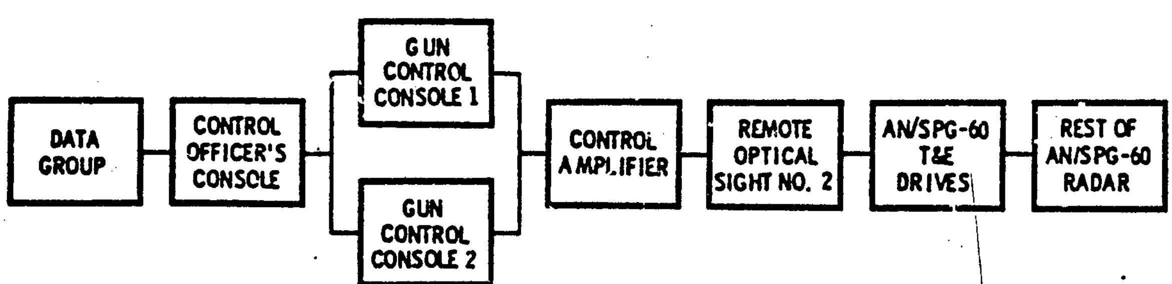


Figure 7. RMA Block Diagram of GFCS Mk 86: Full Air Mode Capability

As of September 1981, Mk 86 achieved the following mission operational availabilities and MTBF's:

TABLE II

MK 86 READINESS BY MISSION

| | $A_o$ | MTBF(HR) |
|---|---|---|
| Indirect Naval Gun Fire Support | 0.96 | 944 |
| Direct Naval Gun Fire Support | 0.95 | 766 |
| Surface Targets | 0.84 | 417 |
| Air Targets | 0.72 | 459 |

These numbers are still not entirely consistent with comments from the Fleet, which indicated frequent radar problems during test firings. However, they do add something to the search for answers to the question of "real" readiness. They point out, for example that there are, as we would expect, more problems in the two operating modes that use radar inputs, and that the air target mode presents the most problems. They also indicate that for two modes the Mk 86 is exceeding its requirements, and that no major effort should be expended in those areas.

Next, we began to analyze the sensitivity of system readiness to various reliability and logistics factors. The definitions we use are based on a measurement called operational readiness (OR), originally introduced by George Tsuchida of the Naval Sea Systems Command, and expanded upon by Lockheed. It takes into account a particular mission, the length of time of the mission, and the probability that the system will be available at the start of a mission and continue to operate for the duration of the mission. The basic definitions for this study are listed below:

| | | |
|---|---|---|
| Goals | - | RMA Goals Specified by SOR 12-04R3, Change No. 1, 11 May 81. |
| Thresholds | - | Minimum Acceptable Levels Specified by SOR 12-04R3, Change No. 1. |
| Demonstrated Values | - | From Data Presented by FLTAC for the Period 1 Jan 79 through 31 Mar 1980. |
| OR | - | Operational Readiness |
| $A_o$ | - | Operational Availability |
| $A_E$ | - | Engagement Availability |
| ER | - | Engagement Reliability |

The basic mathematical relationships involved in this analysis are listed below. This approach was used for the indirect and direct naval gun fire support modes, where the radars are not operating.

| | | |
|---|---|---|
| OR | = | $A_o \times ER$ |
| $A_o$ | = | $\frac{MTBF}{MTBF+MDT}$ |
| ER | = | $e^{-t/MTBF}$ |
| MTBF | = | Mean Time Between Failures |
| MDT | = | Mean Down Time (Including Logistics Factors) |
| t | = | Mission Time |
| e | = | Exponential Function 2.7183 |

For the full air and surface warfare modes, each of which involves use of a radar, a "worst case" model was established based on the radars radiating continuously over extended time periods. This approach is similar to the Naval Air Systems Command's technique of using mean flight hours between failures (MFHBF), except that mean radiate hours between failures (MRHBF) is used. For this analysis, we established the following relationships:

$$OR_{WC} = A_E \times ER_{WC}$$

| | | |
|---|---|---|
| $A_E$ | = | $\frac{MRHBF}{MRHBF + MDT}$ |
| $ER_{wc}$ | = | $e^{-t/MRHBF}$ |
| MRHBF | = | Mean Radiate Hours Between Failure |
| MDT | = | Mean Down Time |
| t | = | Mission Time |

Then, the effects of various sparing approaches on mean down time were estimated using the relationship shown here.

$$MDT = P_{OB}(MTTR + MLTPF_{OB}) + P_{NOB}(MTTR + MLTPF_{NOB})$$

Where

| | | |
|---|---|---|
| $P_{OB}$ | = | Probability of Having an On-Board Spare |
| $P_{NOB}$ | = | Probability of Not Having an On-Board Spare ($1-P_{OB}$) |
| $MLTPF_{OB}$ | = | Mean Logistics Time per Failure when there is an On-Board Spare |
| $MLTPF_{NOB}$ | = | Mean Logistics Time per Failure when there is no On-Board Spare |
| MTTR | = | Mean Time to Repair |

Operational readiness (OR) was then calculated for each of the four missions using measured values, and then recalculated based on planned and projected system reliability improvements. Then, OR improvements likely from logistics improvements were determined. Since many ships did not yet have their full complements of spares, the first logistics model considered only filling the Coordinated Shipboard Allowance List (COSAL) to its specified levels for all operational ships. The second logistics model contemplated additional supply support using such techniques as forward positioning of spares, stocking to a never-out policy, and otherwise increasing the level of supply support to the point where mean logistics time per failure for parts not stocked on board ship is reduced to seven days.

RESULTS OF THE MK 86 RMA ANALYSES

The results of the analysis were compared to NAVSEA's goals and thresholds for each operating mode, and to the current measured data for each mode. The results, which are summarized on Tables III through VII, indicate that this approach offers a more realistic assessment of Mk 86 readiness than the conventional $A_o$ measurement. They also show that NAVSEA's goals of 0.90 availability and thresholds of 0.70 to 0.80 for each mode are achievable, even using the "worst case" analysis, with the logistics and reliability improvements now being contemplated. Although reliability and logistics improvements are needed to assure the full constant readiness desired, the most dramatic improvements come from logistics actions.

These tables show the attendant increases in $A_o$ and OR as various logistics and reliability improvements are made. These equations, which used appropriate mission times of 0.5, 2, and 8 hours in this analysis, could also be used to assess readiness under various other operating scenarios (for example, if the Mk 86 were being used as a navigational aid in a non-tactical mode with "mission times" in the order of several days).

In conclusion, these operational readiness analyses showed that:

- For indirect and direct gun fire support, the Mk 86 system exceeded its goals.
- For full air and full surface capabilities, the Mk 86 system could achieve its thresholds by either logistics or reliability improvements.
- To achieve its goals for full air and surface missions, the Mk 86 system required both logistics and reliability improvements.

Moreover, we now had a set of analytical tools that could assess combat readiness by mission and for varying mission scenarios, and that could be used to predict the relative effectiveness of various reliability and logistics improvements in upgrading readiness.

Table III

Indirect Naval Gun Fire Support: Demonstrated Values for Mission Time of 8 Hours

| | MTBF | $A_o$ | ER | OR |
|---|---|---|---|---|
| CURRENT LOGISTICS SUPPORT LEVEL | 804 HR | .90 | .991 | .89 |
| ABOVE SUPPORT PLUS ALL COSAL SPARES ABOARD SHIP | 804 HR | .94 | .991 | .93 |
| ALL ABOVE SUPPORT PLUS ADDITIONAL SUPPLY SUPPORT | 804 HR | .97 | .991 | .96 |

GOAL: MTBF = 200 HR, $A_o$ = 0.90 THRESHOLD: MTBF = 160 HR, $A_o$ = 0.80

Table IV

Direct Naval Gun Fire Support: Demonstrated Values for Mission Time of 8 Hours

| | MTBF | $A_o$ | ER | OR |
|---|---|---|---|---|
| CURRENT LOGISTICS SUPPORT LEVEL | 592 HR | .89 | .987 | .86 |
| ABOVE SUPPORT PLUS ALL COSAL SPARES ABOARD SHIP | 592 HR | .92 | .987 | .91 |
| ALL ABOVE SUPPORT PLUS ADDITIONAL SUPPLY SUPPORT | 592 HR | .96 | .987 | .95 |

GOAL: MTBF = 200 HR, $A_o$ = 0.90 THRESHOLD: MTBF = 160 HR, $A_o$ = 0.80

Table V

Full Air Target Capability Values for Mission Time of 0.5 Hour (Worst Case Analysis)

| | DEMONSTRATED VALUES | | -IN RADIATE- CURRENT VALUES | | | | -IN RADIATE- WITH UNIT 19 RELIABILITY IMPROVEMENTS | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MTBF | $A_O$ | MRHBF | $A_E$ | $ER_{WC}$ | $OR_{WC}$ | MRHBF | $A_E$ | $ER_{WC}$ | $OR_{WC}$ |
| CURRENT LOGISTICS SUPPORT LEVEL | 268 HR | .73 | 76 HR | .47 | .993 | .47 | 232 HR | .72 | .998 | .72 |
| ABOVE SUPPORT PLUS ALL COSAL SPARES ABOARD SHIP | 268 HR | .87 | 76 HR | .64 | .993 | .64 | 232 HR | .84 | .998 | .84 |
| ALL ABOVE SUPPORT PLUS ADDITIONAL SUPPLY SUPPORT | 268 HR | .93 | 76 HR | .79 | .993 | .78 | 232 HR | .91 | 998 | .91 |

GOAL: MTBF • 180 HR
$A_O$ • 0.90

THRESHOLD: MTBF • 50 HR
$A_O$ • 0.70

Table VI

Full Surface Target Capability Values for Mission Time of 2 Hours (Worst Case Analysis)

| | DEMONSTRATED VALUES | | -IN RADIATE- CURRENT VALUES | | | | -IN RADIATE- WITH UNIT 10 RELIABILITY IMPROVEMENTS | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MTBF | $A_O$ | MRHBF | $A_E$ | $ER_{WC}$ | $OR_{WC}$ | MRHBF | $A_E$ | $ER_{WC}$ | $OR_{WC}$ |
| CURRENT LOGISTICS SUPPORT LEVEL | 260 HR | .75 | 120 HR | .58 | .983 | .57 | 148 HR | .63 | .987 | .62 |
| ABOVE SUPPORT PLUS ALL COSAL SPARES ABOARD SHIP | 260 HR | .85 | 120 HR | .73 | .983 | .72 | 148 HR | .77 | .987 | .76 |
| ALL ABOVE SUPPORT PLUS ADDITIONAL SUPPLY SUPPORT | 260 HR | .92 | 120 HR | .85 | .983 | .84 | 148 HR | .87 | .987 | .86 |

GOAL: MTBF • 200 HR
$A_O$ • 0.90

THRESHOLD: MTBF • 160 HR
$A_O$ • 0.80

Table VII

Full Surface Target Capability Values for Mission Time of 2 Hours (Worst Case Analysis)

| | DEMONSTRATED VALUES | | -IN RADIATE- WITH UNIT 10 AND 11 RELIABILITY IMPROVEMENTS | | | | -IN RADIATE- WITH UNIT 10, 11, AND 12 RELIABILITY IMPROVEMENTS | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MTBF | $A_o$ | MRHBF | $A_E$ | $ER_{WC}$ | $OR_{WC}$ | MRHBF | $A_E$ | $ER_{WC}$ | $OR_{WC}$ |
| CURRENT LOGISTICS SUPPORT LEVEL | 260 HR | .75 | 177 HR | .67 | .989 | .66 | 276 HR | .76 | .993 | .75 |
| ABOVE SUPPORT PLUS ALL COSAL SPARES ABOARD SHIP | 260 HR | .85 | 177 HR | .80 | .989 | .79 | 276 HR | .86 | .993 | .85 |
| ALL ABOVE SUPPORT PLUS ADDITIONAL SUPPLY SUPPORT | 260 HR | .92 | 177 HR | .89 | .989 | 88 | 276 HR | .92 | .993 | .91 |

GOAL: MTBF = 200 HR
$A_o$ = 0.90

THRESHOLD: MTBF = 160 HR
$A_o$ = 0.80

Previously, the Navy had known only that its Mk 86 was exceeding its specified reliability by three-to-one and still not meeting its availability, and that a major investment seemed necessary to improve Mk 86 readiness. Now it knew that the Mk 86 had a better than 95 percent state of readiness for two missions and less than 50 percent for another. Most important, it knew where to put its resources to solve Mk 86 readiness problems.

## LESSONS LEARNED FROM THE MK 86 PROGRAM

From the Mk 86 experience, the surface Navy learned some lessons that it is attempting to apply to other weapon system procurements.

(1) Specify RMA by Mission. - Many weapons systems are multi-mission. To be told that a weapon system has an $A_o$ of .70 is misleading if the system has four missions, each using different subsystems, and the $A_o$ is .50 for the first, .60 for the second, .80 for the third, and .90 for the fourth.

(2) Specify RMA in Terms of Goals. - Before investing in achieving a specified $A_o$ of .90 for each mission, think in terms of the relative importance of each mission to the total ship's mission. Is a particular function primary or backup? If it's backup to another system, why invest in .90 availability if substantial savings can be achieved by settling for, say, .80? Moreover, we know that in a crisis situation we can take extraordinary measures with supply support to achieve .90. Why take these steps in peacetime? Instead of rigid specifications, set goals, which must be attainable in times of crisis. Then monitor systems to assure that the goals can be met or exceeded in wartime.

(3) Analyze Operational Readiness in Terms of Mission Times. - Operational readiness analyses assess the probability that a system will be up and ready at the start of a mission and continue to operate for the duration of a mission. An overall operational availability of .90 and an MTBF of 100 hours would be an inadequate combination if a particular mission had to last for 200 hours. It would, however, be an excellent combination for a half hour air

engagement mission. Unless you analyze by mission times, you don' know the whole story.

(4) Consider "Real World" Situations. - Rather than depend on standard formulas to analyze RMA data and, in turn, ILS requirements, tailor the methodology to realistic situations. For exampl radar systems are generally monitored over a long time period, whic may include a mix of standby and radiate hours. This approach may show acceptable reliability and availability. However, most failures occur during the radiate mode, when high voltage components ar stressed. Not considering a situation based on mean radiate hours between failures can, again, lead to a misleading evaluation of a system's combat readiness.

In summary, if we are going to get the most for our defense dollar, we need to become more sophisticated in our predictions of life cycle cost. More important, we need to understand what we are really getting for our money. The analytical techniques developed for the Mk 86 provide a set of tools for assessing the potential effectiveness of a Navy surface weapon system and evaluating cost vs. increased mission effectiveness for a variety of decisions that the acquisition manager must make.

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BIOGRAPHIES

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Ted Bamforth, a 35-year veteran of naval ordnance programs, is FCS Mk 86 logistics manager at Naval Sea Systems Command in Washington, D.C. Previously, at the Naval Ordnance Station, Louisville, Mr. Bamforth was logistics manager for the program to refit surface ships with 5"54 Mod 10 gun mounts. He planned and coordinated special rail shipments to and from project headquarters in Louisville, where the 50-ton guns were modified and rebuilt. The complex logistics operations involved 10 domestic and two foreign shipyards. Completed on schedule and within budget, the project won Mr. Bamforth a commendation. In 1972, he was part of a team of engineers that received the Presidential Management Award from President Nixon. Mr. Bamforth is currently a member of SOLE.

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Paul Berman is manager of Product Support in LEC's Systems Division, Plainfield, New Jersey. His department is responsible for logistics planning and analysis, supply support, field engineering, training, and technical documentation in support of the division's products. His 25 years of experience in product support include preparation of logistics plans, engineering data, technical publications, and training materials. He is also an adjunct instructor at Rutgers University. Mr. Berman received a BA from Queens College in 1951, and an MA from Hunter College in 1957. He attended the U.S. Army Signal Corps radar school and was a field radio and radar repairman during the Korean War. He is currently a member of SOLE and National Management Association.